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Hummel, Katrin ; Rötzel, Peter

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Mandating the Sustainability Disclosure in Annual Reports – Evidence from the United Kingdom

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Abstract

This study investigates the sustainability disclosure effects of the introduction of the Companies Act 2006 Regulations 2013 in the United Kingdom. The regulation mandates the disclosure of information on greenhouse gas emissions, gender distribution and human rights issues. We examine two research questions: first, whether firms increased disclosure on the mandated topics after the regulation became effective relative to a control group, and second, whether a potential increase in disclosure is moderated by firms' reporting incentives, namely, firms' capital market visibility, growth orientation, governance structure, prior voluntary sustainability disclosure levels and critical media coverage. Our sample consists of the FTSE-350 firms and a matched control group of US firms. We use textual analysis to assess the disclosure of the mandated sustainability topics in firms' annual reports. Specifically, we examine two types of disclosure, namely, the disclosure of the mandated key performance indicators and the narrative disclosure. Our results reveal a significant increase for both types of disclosure relative to the control group. Overall, this treatment effect tends to be smaller for firms with higher reporting incentives, i.e., reporting incentives mitigate the regulatory effect. Taken together, our results suggest that both standards and reporting incentives shape firms' sustainability disclosure level.

Keywords: mandatory sustainability disclosure; regulation; reporting incentives; textual analysis

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1 Introduction

Since the beginning of the 21st century, an increasing number of countries have introduced or are in the process of introducing mandatory sustainability disclosure regulations (KPMG et al. 2016). The most prominent example is European Union (EU) Directive 2014/95/EU, which recently mandated the disclosure of nonfinancial and diversity information for certain large companies.[1] Such mandatory sustainability disclosure regulations typically aim to achieve enhancements in "the consistency and comparability of non-financial information" (No. 6 2014/95/EU) and to trigger shifts toward a more sustainable economy (No. 3 2014/95/EU).

However, the empirical evidence is mixed regarding the results achieved by these regulatory interventions in the context of sustainability disclosure. While Ioannou and Serafeim (2017) document an increase in the level of firms' corporate sustainability disclosure following the introduction of mandatory regulations in four countries, the results from other studies reveal generally low compliance with the regulations and thus no significant improvements in firms' sustainability disclosure (Chauvey et al. 2015; Fallan and Fallan 2009; Larrinaga et al. 2002). Findings of noncompliance with reporting standards are also obtained for financial disclosure (Glaum et al. 2013; Glaum and Street 2003). In this context, researchers often examine the mandatory adoption of International Financial Reporting Standards (IFRS) and the consequences for accounting quality. Based on a review of empirical studies, Brüggemann et al. (2013) conclude that the literature does not provide evidence for an increase in the comparability and transparency of financial disclosures after the switchover to IFRS. More recently, Leuz and Wysocki (2016) reached the same conclusion. This finding is consistent with an "*incentives-based" view* of reporting regulation (Ball et al. 2003). Since disclosure regulations generally provide managers with reporting discretion, researchers argue that both reporting standards and reporting incentives determine reporting practices across firms and countries. These reporting incentives are shaped by institutional and firm-level factors (Leuz and Wysocki 2016).

[1] The addressees of the directive are specified as follows: "[…] the obligation to disclose a non-financial statement should apply only to those large undertakings which are public-interest entities and to those public-interest entities which are parent undertakings of a large group, in each case having an average number of employees in excess of 500, in the case of a group on a consolidated basis." (EU Directive, recital 14.) In addition, the guidelines on non-financial information provide further guidance. "While the disclosure requirements concerning non-financial information apply to large-public interest entities which more than 500 employees, the disclosure requirements concerning board diversity apply only to large listed companies." (Guidelines on non-financial reporting, footnote 1.)

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While there is a growing literature on the role of the institutional environment in the context of financial disclosure (Ball et al. 2000; Ball et al. 2003; Bushman and Piotroski 2006; Daske et al. 2008, 2013; Leuz et al. 2003), there is only limited empirical evidence on the role of firm-level factors in a mandatory setting. For instance, Christensen et al. (2015) show that accounting quality improvements after IFRS adoption are confined to voluntary adopters. Digging deeper into the specific firm-level factors, empirical evidence suggests that capital market visibility, growth orientation and the strength of corporate governance impact accounting quality improvements (Bassemir and Novotny-Farkas 2018; Glaum et al. 2013; Glaum and Street 2003; Verriest et al. 2013). In addition, Daske et al. (2013) show that decreases in the cost of capital and increases in liquidity after IFRS adoption are limited to "serious" IFRS adopters.

Against the background of the inconsistent empirical evidence in the context of financial disclosure regulations in general and sustainability disclosure regulations in particular, we address the lack of consensus in the literature and outline the debate by investigating the consequences of the introduction of the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 (the "SR Regulations") in the United Kingdom (UK) on firms' disclosure of sustainability information in their annual reports. The SR Regulations mandate the disclosure of sustainability-related information in annual reports for listed companies in the UK and became effective for financial years ending on or after 30 September 2013. Specifically, they mandate disclosure on greenhouse gas (GHG) emissions, gender breakdown and human rights issues. We are interested in two research questions. First, we investigate whether the introduction of the SR Regulations is associated with an increase in sustainability disclosure in the annual reports among treated firms relative to a control group (i.e., the treatment effect). Second, we consider whether firm-level factors are associated with changes in sustainability disclosure after the SR Regulations took effect (i.e., the compliance effect). Based on prior research, we focus on capital market visibility, growth orientation, governance structure, firms' prior level of voluntary sustainability disclosure and negative media coverage (Bassemir and Novotny-Farkas 2018; Brown and Deegan 1998; Cormier et al. 2005; Daske et al. 2013; Fallan and Fallan 2009; Ioannou and Serafeim 2017; Neu et al. 1998; Verriest et al. 2013). Although we know from the literature that firms with greater reporting incentives are more likely to provide higher disclosure levels in a voluntary setting (i.e., the selection effect), it is unclear how the selection effect and the treatment effect interact. The effects might be complementary, thereby indicating that firms with greater reporting incentives are more likely

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to comply with the regulation. However, the effects might also be substitutes. In this case, the selection effect mitigates the treatment effect since firms have higher voluntary disclosure levels to start with.

To assess firms' sustainability disclosure, we use computer-assisted textual analysis. Textual analysis generally denotes the "notion of parsing text for patterns" (Loughran and McDonald 2016, p. 1187). Because of a steady rise in both computing power and the availability of electronic firm disclosures over the last decades, textual analysis is increasingly applied in finance and accounting research (Loughran and McDonald 2016). By using textual analysis, our measurement of sustainability disclosure is objective, reliable and replicable. We assess two types of disclosure, namely, disclosure of the mandated key performance indicators and narrative disclosure on the mandated topics. To capture whether firms disclose the mandated key performance indicators, we define search queries that require the disclosure of specific words in combination with numerical content within a window of five words. For our narrative topic-specific disclosure measures, we rely on a methodology that closely follows Hoberg and Maksimovic (2015) and Hummel et al. (2017). For each topic, we assess the similarity of the annual report with text corpora that captures the mandated subjects.

The sample consists of firms listed in the FTSE-350 index and a control group of US firms, which are matched by firm size, compliance with the Global Reporting Initiative (GRI) reporting guidelines and industry group. We use a difference-in-difference-in-difference approach to compare the treatment effect between firms with low and firms with high reporting incentives. The results reveal a significant increase in the disclosure of both key performance indicators and narrative disclosures on the mandated topics among treated firms relative to the control group after the Companies Act 2006 Regulations 2013 became effective. Before the regulation in 2012, our search query reveals that approximately 76 percent (30 percent) of the FTSE-350 firms provided quantitative information on GHG emissions (gender distribution), whereas after the regulation, this proportion increased to 90 percent (73 percent) in 2013. We find this increase for firms with both low and high reporting incentives. With respect to firm-level reporting incentives, we find evidence that firms with high reporting incentives provide more disclosure on the mandated topics in a voluntary setting (i.e., during the pre-regulatory period or in the control group). Thus, firms with greater reporting incentives are more likely to self-select into higher voluntary disclosure levels, which is consistent with prior literature. In addition, our results reveal that the selection effect

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partially mitigates the treatment effect. As a consequence, the treatment effect tends to be lower for firms with high reporting incentives. We find this negative triple-difference estimator for capital market visibility (measured by the number of analysts following), governance mechanisms, and prior sustainability disclosure level, but only for some of our disclosure measures. With respect to firms' growth orientation, we find a complementary effect, i.e., growth-oriented firms provide a significantly larger increase in disclosure after the regulatory intervention. We do not find evidence that negative media coverage affects the disclosure on the mandated topics.

We conduct additional tests to further investigate our findings. Specifically, our results hold for different model specifications, including additional control variables and firm fixed effects. However, when we shift the event date prior to 2013, the results remain positive and significant, thereby indicating that there might be anticipatory effects; i.e., firms might have adapted their disclosures even before 2013. We also apply different specifications for the measurement of our disclosure variables, and these specifications do not alter our findings. In addition, for the narrative disclosure, we use measures based on word counts according to a sustainability dictionary developed by Pencle and Mălăescu (2016). The results reveal significant increases in disclosure only for the employee and human rights dimension but not for the other sustainability dimensions covered by the dictionary (environmental and social), thereby indicating that the regulation does not result in substantial spillover effects for disclosure on other sustainability topics. Finally, we also examine changes in traditional textual attributes, namely, tone, readability, numerical content and report length. While we find no change in tone, the reports are significantly longer and more readable and contain more numerical content after the adoption of the SR Regulations.

This study aims to contribute to the literature in several ways. First, our study responds to the call of Johansen (2016, p. 4) for more "social and environmental accounting research that focuses on how, why and to what extent regulation, mandatory or by guidelines, as well as voluntary disclosure may influence reporting practices." In a similar vein, Hombach and Sellhorn (2018, p. 27) call for more "empirical evidence on targeted transparency via corporate disclosure regulation." Prior large-sample research often focuses on the overall sustainability disclosure level (Ioannou and Serafeim 2017), thereby intermingling voluntary and mandatory disclosure items. The use of textual analysis allows us to tailor our analysis to the mandated disclosure items and distinguish between disclosure of key performance

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indicators and narrative disclosure. Our results reveal an increase in both types of sustainability disclosure on the mandated topics. Thus, the regulation appears to be effective in stipulating both the disclosure of the mandated key performance indicators and narrative disclosure on the mandated topics, although reporting discretion varies for these two types of disclosure. This finding indicates that even a modest[2] disclosure regulation can stimulate an increase in sustainability information in firms' annual reports. Second, our study provides additional insights into the role of firm-level factors in the context of mandatory disclosure regulations. While numerous studies investigate the role of the institutional environment in the context of financial disclosure, empirical evidence on firm-level factors is still scarce. Our results show that reporting incentives interact with regulatory effects. Specifically, we find some evidence for a negative interaction between the two effects, thereby indicating that the regulatory effect is smaller for firms with greater reporting incentives, particularly firms with higher capital market visibility, stronger corporate governance mechanisms and higher prior voluntary sustainability disclosure level. However, this negative interaction does not lead to a complete "crowding-out" of the regulatory effect, as the overall treatment effect remains positive and significant even for firms with high reporting incentives. In addition, for firms with high growth orientation we find a positive interaction, i.e., these firms are more likely to comply with the regulation. Taken together, our study provides further evidence on the role of the "incentives-based" view on disclosure regulation. Third, by examining traditional textual characteristics, we link our findings to the growing literature that uses textual analysis to study financial and nonfinancial disclosure. Our results indicate that the regulatory intervention results in longer and more readable annual reports that contain more numerical content.

In addition to its contributions to the academic literature, our study has practical implications, particularly for firms and regulatory bodies. For firms, the results show that high levels of voluntary sustainability disclosure enable better compliance with mandatory sustainability disclosure regulations. Against the background of recent developments in both Europe and the US[3], we therefore encourage firms to build up their corresponding management and reporting systems. With respect to regulators, the findings reveal that the regulation is effective in

[2] Compared to other sustainability disclosure regulations (e.g., the Grenelle I and Grenelle II in France, which mandate the disclosure of 42 sustainability-related performance indicators in firms' annual reports), we consider the disclosure requirements of the SR Regulations as "modest".

[3] In the US, the Securities and Exchange Commission (SEC) is currently discussing a concept that would require the disclosure of public policy and sustainability matters.

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stipulating higher sustainability disclosure on the mandated topics. The results from our robustness tests reveal only limited spillover effects to other sustainability dimensions.

The remainder of the paper is structured as follows. The next section presents the theoretical background of the paper. More specifically, we provide information on the regulation and develop our research questions against the background of theory and prior financial and sustainability disclosure literature. In section three, the research design is explained. Section four provides the descriptive statistics and the main findings from our regression analyses. Section five presents numerous robustness checks and additional analyses. The final section concludes the paper.

2 Institutional Background, Prior Literature and Research Questions

2.1 The Companies Act 2006 Regulations 2013

The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 (the "SR Regulations") came into force on October 1, 2013, and apply to financial years ending on or after September 30, 2013. The SR Regulations extend the scope of sustainability reporting, mainly through the duty to prepare a management commentary, referred to as the *strategic report,* which replaces the former business review and the operating and financial review. The new regulation mandates the disclosure of specific sustainability information.[4]

More specifically, the report must contain a gender breakdown of the company's employees by employee category (Article 414) and must state the "annual quantity of emissions in tons of carbon dioxide equivalent from activities for which that company is responsible" (Article 465). If the required information is not provided, the report must explicitly state this; with respect to GHG emissions, the report must explain why the information is not provided.

In addition, the strategic report must include – in the case of a listed company – "to the extent necessary for an understanding of the development, performance or position of the company's business, […] information about

[4] Small companies are exempt from creating a strategic report, and medium-sized companies do not need to comply with reporting on sustainability indicators, unless they are listed. According to Article 465 of the Companies Act, a company qualifies as medium-sized if two of the following criteria are met in two consecutive years: (1) Turnover not more than £ 25.9 million, (2) a balance sheet not more than £ 12.9 million, and (3) not more than 250 employees.

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(i) environmental matters (including the impact of the company's business on the environment),
(ii) the company's employees, and
(iii) social, community and human rights issues,

including information about any policies of the company in relation to those matters and the effectiveness of those policies." (Article 414)

The strategic report must be approved by the board of directors and signed on its behalf (Article 414D). Noncompliance results in a monetary sanction for the persons responsible.

It is important to note that prior regulation also requires the disclosure of sustainability information in accordance with the EU Modernization directive (Directive 2003/51/EC). According to the Companies Act 1985 Regulations 2005, the annual report must include "to the extent necessary for an understanding of the development, performance or position of the business of the company […], where appropriate, […] information relating to environmental matters and employee matters." Therefore, the changes between the prior regulation and the SR Regulations particularly relate to the additional disclosure on GHG emissions and the gender breakdown and the additional disclosure of general information on human rights issues. For further guidance on the SR Regulations, the Financial Reporting Council (FRC) has published "Guidance on the Strategic Report," and the Department for Environment Food & Rural Affairs (DEFRA) has provided "Environmental Reporting Guidelines". The latter document provides detailed guidance on the reporting of environmental information.

2.2 Theory, Literature and Research Questions

2.2.1 The Role of Mandatory Disclosure Regulation

In a voluntary setting, traditional accounting theory suggests an equilibrium disclosure level in which the marginal costs of disclosure equal its marginal benefits (Verrecchia 2001). Mandatory reporting requirements typically represent an external shock to this equilibrium with subsequent consequences on firms' disclosure. However, empirical evidence on the disclosure effects of mandatory regulation is mixed. In the context of financial disclosure, this mixed empirical evidence is documented in studies on compliance with specific accounting

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rules (Glaum et al. 2013) and studies on accounting quality changes after IFRS adoption[5] (for an overview, see Brüggemann et al. 2013; Leuz and Wysocki 2016).[6] Similarly inconsistent findings are obtained in the context of sustainability disclosure regulations. Studies that tend to document an increase in sustainability disclosure in response to the introduction of mandatory disclosure regulations include Ioannou and Serafeim (2017) and Albertini (2014). Studies that find no significant association between mandatory sustainability disclosure regulations and sustainability disclosure include Larrinaga et al. (2002), Fallan and Fallan (2009), Bebbington et al. (2012), Peters and Romi (2013) and Chauvey et al. (2015).

Potential reasons for noncompliance include unintentional neglect, misinterpretation of disclosure rules, and intentional noncompliance – the last originating from cost-benefit considerations (Glaum and Street 2003). In a mandatory setting, benefits typically arise from the avoidance of sanctions in the case of noncompliance, which are less likely in the case of a vaguely phrased reporting regulation.[7] Specifically, the existence of a "comply-or-explain" clause, which is often present in sustainability disclosure regulations, transforms the disclosure decision from mandatory to voluntary setting.

As a consequence, the mixed empirical evidence on the effectiveness of sustainability disclosure regulations needs to be assessed against the background of the specific disclosure regulations under study. For instance, the French sustainability disclosure regulations are "orientation laws" with no sanctions for noncompliance (Chauvey et al. 2015; Delbard 2008). In the Norwegian context, the phrasing of the regulation was originally very vague but became more specific over time (Fallan and Fallan 2009). Only the Spanish regulation under study is relatively specific and – as the environmental information must be incorporated into the notes to the financial statements – even subject to financial audit. However, because of a general lack of normativity, legitimacy and enforcement, compliance with the law was low (Bebbington et al. 2012). Similarly, Peters and Romi (2013) speculate about a lack of enforcement as potential reasons for low compliance in the US context. Taken together, the

[5] The switchover to IFRS is probably the largest change in an entire set of accounting standards to date and thus serves as a research setting for a vast number of studies on the consequences of financial disclosure regulation.
[6] In addition, other streams of research focus on restatements of accounting errors (Cao et al. 2012; DeFond and Jiambalvo 1991; Palmrose and Scholz 2004) and earnings management in general (for a review, see Healy and Wahlen 1999). We do not explicitly account for this literature, as these studies typically focus on influencing/misleading stakeholders through financial disclosures.
[7] If a reporting regulation is only vaguely phrased, it is more difficult to determine non-compliance.

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phrasing of legislation and potential sanctions in the case of noncompliance and enforcement appear to be crucial for the effectiveness of disclosure regulation.

In the context of the SR Regulations, the phrasing of the regulation is precise with respect to the disclosure of GHG emissions and gender distribution. It does not specifically require narrative disclosure of key performance indicators. Because of the inclusion of the clause "to the extent necessary for an understanding of the development, performance or position of the company's business", reporting discretion is greater for the narrative disclosure on human rights issues than for the disclosure of key performance indicators. In addition, the regulation refers to monetary sanctions for the persons responsible in the case of noncompliance. We expect that these properties of the SR Regulations will support firms' compliance with the regulation. We refer to this effect as the "treatment effect" of the regulation and propose the following research question:

RQ1: Do U.K. firms, on average, increase their disclosure of information on GHG emissions, gender breakdown, and human rights issues in their annual reports relative to a matched control group of US firms after the introduction of the SR Regulations?

2.2.2 The Role of Firm-Level Reporting Incentives

Despite the characteristics of the regulation itself, an additional explanation for the inconsistent findings on the disclosure effects of mandatory regulations is provided by the "incentives-based" view of reporting regulation. Mandatory reporting requirements often leave managers with reporting discretion for two reasons (Leuz and Wysocki 2016). First, reporting standards cannot account for all eventualities that may arise when applying the standards in the future. Second, by granting discretion, reporting standards force managers to use their private information in applying the standards; the resulting disclosure thus allows for partly inferring this private information. Researchers therefore argue that reporting practices are determined not only by reporting standards but also by firms' reporting incentives (Ball et al. 2000; Ball et al. 2003). These reporting incentives are shaped by both institutional (Ball et al. 2000; Ball et al. 2003; Burgstahler et al. 2006; Bushman and Piotroski 2006; Daske et al. 2008, 2013; Leuz et al. 2003) and firm-level factors (Bassemir and Novotny-Farkas 2018; Christensen et al. 2015; Glaum and Street 2003; Verriest et al. 2013). Firm-level reporting incentives may affect firms' disclosure in both a voluntary and a mandatory setting. In a voluntary setting, firms with greater reporting incentives are more likely to provide higher

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levels of voluntary disclosure ("selection effect"). Whether this relationship also prevails in a mandatory setting is unclear. Specifically, firms' reporting incentives may be related to the relative increase in the disclosure level in response to the regulatory intervention (we refer to this effect as the "compliance effect"). Our second research question therefore asks for the *incremental* effect of firm-level reporting incentives in the context of the introduction of the SR Regulations. We formally posit the following research question:

RQ2: Do firm-level reporting incentives, on average, interact with the increase in disclosure of information on GHG emissions, gender breakdown, and human rights issues in the annual reports of U.K. firms after the introduction of the SR Regulations relative to a matched control group of US firms?

Following the prior literature, we focus on capital market visibility proxied by analyst coverage (Bassemir and Novotny-Farkas 2018; Lang et al. 2004), growth orientation (Bassemir 2018; Verriest et al. 2013), corporate governance mechanisms (Eng and Mak 2003; Ernstberger and Grüning 2013; Verriest et al. 2013), prior voluntary sustainability disclosure (Fallan and Fallan 2009) and critical media coverage (Brammer and Pavelin 2004; Brown and Deegan 1998; Neu et al. 1998). The literature shows that these proxies reflect stronger reporting incentives in a voluntary setting because of stronger internal and external monitoring (capital market visibility and corporate governance mechanisms), higher external financing needs (growth orientation), higher implementation levels of sustainability-related management and reporting systems and thus lower marginal costs of disclosure (prior voluntary sustainability disclosure), and larger legitimacy gaps[8] (critical media coverage).

3 Research Design

3.1 Sample Selection and Description

With regard to our research questions, we use a difference-in-difference analysis to examine the change in disclosure among UK firms after the regulation became effective relative to a control group of US firms. We focus on US firms as our control group because there are no mandatory sustainability disclosure regulations in the US that may confound our results.

[8] Legitimacy refers to the perception that a firm's actions are in accordance with a "socially constructed system of norms, values, beliefs, and definitions" (Suchman 1995). Corporate sustainability disclosure can serve as a means to close legitimacy gaps (Sethi 1978).

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Moreover, by restricting our analysis to English-speaking countries, we avoid bias attributable to translation issues.

Panel A of Table 1 provides an overview of the sample selection. Our sample period starts in 2010, three years prior to the implementation of the SR Regulations, and runs through 2015, the last year with sufficient data available in the databases. We start with all firms included in the FTSE-350 index as of January 2017 and construct a control group of US firms drawn from the S&P-500 and the S&P-1000 index. More precisely, we match the US firms to the UK firms based on industry group, firm size (five categories based on the percentile rank of total assets) and compliance with the GRI reporting guidelines (compliance versus noncompliance) in 2012 (i.e., the year before the regulation became effective).[9]

We start with 2,100 firm-year observations for our treated group of FTSE-350 firms and manually retrieve the corresponding annual reports as PDF files. The sample of treated firms is reduced by 284 observations for which we cannot retrieve the corresponding annual report, 342 observations for which the annual reports cannot be processed in the textual analysis, and 232 observations with missing control variables.[10] Thus, our sample of treated firms comprises 1,242 observations. The matching procedure results in 1,175 firm-year observations for the matched sample of US firms. For the US firms, we retrieve 10-K documents from the SEC's Electronic Data Gathering, Analysis, and Retrieval (EDGAR). The combined sample of treated firms and matched control firms thus totals 2,417 firm-year observations. It is important to note that the sample is not completely balanced. Specifically, we do not exclude U.K. observations for which the annual report in 2012 is missing and thus, there is no matched control firm.[11]

The results from a t-test of mean differences reveal no significant differences in firm size (t=-0.4827) and GRI compliance (t=-0.1802) between treated and matched firms for the reporting year 2012, thereby indicating that the matching procedure works reasonably well.

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[9] Matching on the level of sustainability disclosure (e.g., proxied by the Bloomberg ESG disclosure score) is not feasible since on average, the US firms have remarkably lower disclosure levels.
[10] Files that cannot be processed in the textual analysis refer to PDF files with copy protection.
[11] In addition, we manually adjust the reporting year if a firm's fiscal year ends before July. We do not adjust the reporting year if the fiscal year ends in August or September, which might slightly bias our findings.

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Insert Table 1 about here

Panel B of Table 1 provides an overview of the sample by year. As shown, our sample is not balanced, as we allow for an increase among treated observations after 2012 (because of the availability of the reports). Panel C of Table 1 provides an overview by industry group (one-digit SIC code). Except for the industry group "mining and construction", there are no substantial differences in the sample distribution by industry.

3.2 Empirical Model and Variables

To examine the treatment effect of the regulation (RQ1) and the compliance effect of reporting incentives (RQ2), we estimate equation (1) for the sample of treated and matched firms:

$$(1)\text{disclosure} = \beta_0 + \beta_1\text{treated} + \beta_2\text{post x treated} + \beta_3\text{inc} + \beta_4\text{post x incentive} + \beta_5\text{treated x incentive} + \beta_6\text{post x treated x incentive} + \sum_i \beta_i\text{controls} + \sum_j \beta_j\text{fixed\_effects} + \varepsilon$$

All of the variables are summarized in Table 2. The disclosure variables are described in greater detail in section 3.3, and the variables that proxy for reporting incentives are described in section 3.4. The main variables of interest and the control variables are described below. $fixed\_effects_i$ denotes year-fixed effects.[12] In the robustness section of the paper, for some analyses we employ a more parsimonious model that excludes the moderating effects (i.e., without β_4, β_5 and β_6) so that the reader can more easily process the main findings. Our research setting differs substantially from prior research on sustainability disclosure regulation, which often does not include a matched control group or a simultaneous investigation of the effect of reporting incentives and the treatment effect (Albertini 2014; Chauvey et al. 2015; Fallan and Fallan 2009; Peters and Romi 2013).

Insert Table 2 about here

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[12] Thus, the main effect of post is not included in the regression since it is captured by the year-fixed effects.

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post is a dummy variable that takes the value 1 beginning with the year the SR Regulations became effective, i.e., the year 2013. *treated* is a dummy variable that takes the value 1 for firms on the FTSE-350 index, i.e., firms domiciled in the UK. *incentive* proxies for firm-level reporting incentives (see section 3.4). With respect to research question RQ1, i.e., the treatment effect, we are particularly interested in β_2 (*postxtreated*) and the sum of β_2 (*postxtreated*) and β_6 (*postxtreatedxincentive*). β_2 (β_2+β_6) indicates the change in the sustainability reporting behavior of treated firms *relative* to control firms after the SR Regulations became effective for firms with low (high) reporting incentives. With respect to the incentive effect, β_3, (β_3+β_4) and (β_3+β_5) capture the effects of firm-level reporting incentives in a voluntary setting, while (β_3+β_4+β_5+β_6) capture the effects of reporting incentives in a mandatory setting. Moreover, β_6 captures the *incremental* effect of reporting incentives on the treatment effect. A positive (negative) coefficient thus indicates whether there is a complementary (substitutive) relationship.

We control for numerous firm-level variables, namely, GRI compliance (*gri*), report length (*report_length*), firm size (*size*), financial performance (*roa*), and leverage (*lev*). GRI compliance (*gri*) proxies for the firm's adherence to the GRI sustainability reporting guidelines. We focus on the GRI sustainability reporting guidelines because they are the most common voluntary sustainability disclosure guidelines (Hahn and Kühnen 2013).[13] We obtain data on the application of the GRI reporting guidelines from the Bloomberg database. Firms that follow the GRI guidelines might provide more disclosure on the mandated topics because of existing voluntary sustainability reporting. In addition, we control for the length of the annual report, as more comprehensive reports are more likely to cover the predefined topics. We measure *report_length* as the logarithm of the total word count of each report. Firm size (*size*) is measured as the natural logarithm of total assets for each reporting year. In accordance with previous studies, we expect to observe a positive relationship between size and sustainability disclosure attributable to economies of scale with respect to information production costs and the higher public visibility of large companies (Clarkson et al. 2008; Clarkson et al. 2011; Patten 2002). Financial performance (*roa*) is measured as the return on total assets for each reporting year. Prior research on the relationship between *roa* and

[13] The GRI was founded in Boston in 1997 as a non-governmental organization aiming to develop a sustainability reporting standard. In 2000, the GRI launched the first version of its sustainability reporting guidelines (G1). In 2016, the latest version of the guidelines – the GRI standards – was released.

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voluntary sustainability disclosure is ambiguous (for a positive relationship, see Cormier et al. 2005; for a negative relationship, see Neu et al. 1998; for an indifferent relationship see Patten 1991), and we therefore expect no sign for this relationship. We also account for the financial leverage of a company (*lev*), which is measured as a firm's total debt divided by its total assets for each reporting year. Financial leverage serves as a proxy for creditors' influence. To limit the influence of outliers, we winsorize size, roa, and lev at the top and bottom 1%.

3.3 Measurement of Disclosure

The financial disclosure literature usually refers to overall measures of accounting quality, such as earnings management and timely loss recognition, as direct measures of disclosure quality (Bassemir and Novotny-Farkas 2018; Christensen et al. 2015) or capital market measures, such as market liquidity and cost-of-capital, as indirect measures of disclosure quality (Daske et al. 2008). Less prevalent is the use of self-constructed indices and hand-collected data (Botosan 1997; Glaum et al. 2013; Hail 2002; Verriest et al. 2013), which is by far more common in the sustainability disclosure literature.[14] While the use of self-constructed indices and hand-collected data comes at the expense of small sample sizes, it is particularly useful when measuring specific aspects of disclosure quality, such as compliance with specific reporting rules (Glaum et al. 2013; Krause et al. 2017; Verriest et al. 2013), the amount of *voluntary* disclosure in annual reports (Botosan 1997; Hail 2002) and the quantity and quality of sustainability disclosure (e.g., Cho et al. 2012; Cho and Patten 2007; Clarkson et al. 2008).

To overcome the limitations of small sample sizes and nevertheless utilize a disclosure measure that is tailored towards specific disclosure content, we use computer-assisted textual analysis to measure the disclosure on the mandated topics, namely, GHG emissions, gender distribution and human rights issues, in firms' annual reports. Specifically, we use Python and the nltk and gensim packages. Prior to the textual analysis, we apply various standard preprocessing procedures to enhance the comparability of the text corpora.[15]

[14] The higher prevalence of self-constructed indices and hand-collected data in the sustainability disclosure literature most likely results from a lack of sufficient databases for the measurement of sustainability disclosure.
[15] These pre-processing procedures include the elimination of line breaks, tabulators, unicode-wide characters and blanks that occur several times in sequence. We then split the text into single words (tokens) and eliminate all single characters and stop words. Stop words are words that appear frequently throughout a text but convey only minimal meaning (for instance, "a", "the", and "of"). For the identification of stop words, we rely on a list provided by McDonald (2017). In addition, we eliminate the names of the sample firms. Finally, we lemmatize the tokens using the "wordnet" lemmatizer.

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We measure two types of disclosure. First, we assess whether the report provides information on the mandated key performance indicators, namely, the amount of GHG emissions and gender distribution. For that purpose, in an iterative process, we define search queries based on the SR Regulations.[16] Table 3 provides the logical expressions of the search queries. To identify reports that contain the mandated information on GHG emissions, one of the following words, "tonne" or "ton", or a numeric expression must appear together with one of the following words, "GHG", "*co2*", "carbon", or the bigram, "greenhouse gas", within a word window of five words (including the key words).[17] Note that * denotes a wildcard. A numeric expression is defined as Arabic numerals or quantitative words. To identify reports that comprise the mandated information on gender distribution, the report must contain the words "female" or "gender" or "woman" or "sex" *and* "board" or "director" or "manager" or "executive" or "employee" *and* a numeric expression. In addition, we allow for the bigrams "gender distribution", "gender split" or "gender breakdown", which have to appear within the word window together with a numeric expression. Our disclosure measures *ghg_KPI* and *gender_KPI* indicate whether a report loads on the query (equals 1) or not (equals 0) and thus whether it contains the mandated information.

Insert Table 3 about here

Second, we measure the extent to which the report *broadly* covers the mandated topic, i.e., the narrative topic-specific disclosure. To capture the narrative disclosure for each topic, we broaden our search queries (see Table 3). Based on the results from the search queries, we construct ten-word windows by retrieving the words that appear directly before and after the keywords. With respect to the topic of human rights, we search for the bigram (human, right), meaning that the two words have to appear side by side (separated only by stop words). Note

[16] The search queries were defined in an iterative process. In this process, we realized that the occurrence of a numeric expression is essential in identifying the mandated key performance indicators. In addition, we realized that including the words "sex", "gender" and "woman" in the search queries improves the identification of information that is presented in tables. Similarly, including a wildcard before and after 'CO2' captures expressions such as 'CO2e' (CO2 equivalents) and 'tCO2' (tons of CO2).

[17] Thus, the search terms must appear side by side, separated by not more than three (two words in case of greenhouse gas) words (excluding stop words).

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that we construct the word windows by centering the keywords into the word windows.[18] We focus on a limited number of typical words since large word lists are much more prone to error because of the ambiguous meaning of words (Loughran and McDonald 2016). Next, we collect all retrieved word windows to construct a topic-specific vocabulary. By constructing topic-specific vocabularies, we account for additional words that typically appear in the context of the identified search terms. We measure the similarity of each report's vocabulary to the topic-specific vocabulary by calculating the cosine similarity (Hoberg and Maksimovic 2015; Hummel et al. 2017). The cosine similarity is computed as the inner product of two vectors: one vector characterizing the word usage in each report and the other calculating the word usage in the vocabulary. For conventional reasons, we multiply the cosine similarity by 100. In section 5.2, we run our analyses with alternative disclosure measures.

Our procedures for constructing the disclosure measures are described in more detail in Appendix I. Examples of incorrect classifications with regard to *ghg_KPI* and *gender_KPI* and the corresponding firm disclosure are provided in Appendix II.

3.4 Reporting Incentives

With respect to reporting incentives, we focus on capital market visibility (*analysts*), growth orientation (*growth*), corporate governance (*governance*), prior sustainability disclosure level (*prior_discl*), and critical sustainability-related media coverage (*media*). Similar to prior studies (Lang et al. 2004; Roulstone 2003), we measure capital market *visibility* based on the number of analysts following a firm (retrieved from the I/B/E/S database). We use a median split by each year to distinguish between high (above median) and low (below median) capital market visibility. For the measurement of a firm's growth orientation, we follow Verriest et al. (2013) and use the market-to-book value. Again, we construct a binary variable (*growth*) that equals 1 for values above the median and 0 for values below the median. With respect to the strength of the firm's governance mechanisms, we run a principal component analysis on four variables retrieved from the Bloomberg and ASSET4 database, namely, whether the board has a policy for maintaining effective board functions, whether the company has a corporate governance board, whether the company has an audit committee and the percentage of independent directors. Similar to the other variables, we construct a binary variable

[18] Thus, the number of words that appear before and after the search terms is dependent on the number of words between the search terms.

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(*governance*) that equals 1 for values above the median and 0 otherwise. We measure a firm's prior sustainability disclosure level based on the Bloomberg ESG disclosure score (Ioannou and Serafeim 2017). The Bloomberg ESG disclosure score measures a firm's disclosure in the areas of environmental, social and corporate governance based on 100 out of 219 raw data points and ranges in the interval between 0 and 100. Our variable *prior_discl* equals 1 if a firm's sustainability disclosure level is above the yearly sample median and 0 otherwise. Finally, we measure negative media coverage based on the number of negative media articles on environmental, social and human rights topics published for a given firm-year in UK and US newspapers.[19] We retrieve the number of articles from Factiva. Our variable media equals 1 for negative media coverage that is above the yearly sample median and 0 otherwise.

4 Results

4.1 Descriptive Statistics

Panel A of Table 4 presents the descriptive statistics for the regression variables for the sample of treated and matched firms. The mean values for *ghg_specific* (*gender_specific*) indicate that on average, 49 percent (28 percent) of the reports contain the mandated information on GHG emissions (gender distribution). The results for the narrative disclosure measures are much lower and are close to zero, similar to the findings of prior studies that utilize this approach (Hoberg and Maksimovic 2015; Hummel et al. 2017).[20] *post* indicates that 52 percent of our observations relate to the period after the SR Regulations became effective; *treated* indicates that 51 percent of our observations belong to the treatment sample. Regarding the variables that proxy for reporting incentives, we report the untransformed values.[21] On average, each firm has 16 analysts with a minimum of no analysts following and a maximum of 44 analysts following (original, untransformed values). Market-to-book value

[19] The search query is composed the following logical expression for environmental topics: ((ECOLOGY or EMISSION or WATER or ENVIRONMENTAL or OIL or WASTE or (PALM and OIL) or (NUCLEAR and POWER) or ENERGY) and (LEAK or CONTROVERSY or DAMAGE or CRITICISM or RECALL or VIOLATION or crisis)) or POLLUTION or (LAND and CONTAMINATION) or (OIL and SPILL) or (WASTE and DISCHARGE) or (TOXIC and WASTE) or CONTAMINATION or ASBESTOS.
The search query is composed of the following logical expression for social and human rights topics: ((POOR or UNSAFE or UNFAIR) and (WORK or WORKING or EMPLOYMENT)) or (CHILD and LABOR) or (WORKER and DEATH) OR (SEXUAL and EXPLOITATION) or (LAND and GRAB) or (((TRADE and UNION) or WORKER or WORK OR LABOR or (HUMAN and RIGHT)) and (ABUSE or DISCRIMINATION or SUPPRESSION or REPRESSION or VIOLENCE OR CRTICISM or CONTROVERSY or DEATH or VIOLATION)).

[20] Note that for reasons of convenience, the values of the cosine similarity are multiplied by 100.

[21] Note that the variables that proxy for firm-level reporting incentives are transformed based on a median split of the sample for each year.

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equals on average 1.13, thereby indicating that on average, the firms have growth opportunities. Because of the standardization of the original items, the mean values of the factor scores for *governance* are close to zero, with a standard deviation of close to one. The prior sustainability disclosure level has a mean value of 30.46 with a minimum of 6.2 and a maximum of 75.62. Compared to prior research, these values are considerably high (Ioannou and Serafeim 2017) and might originate from the relatively high level of voluntary sustainability disclosure that has developed over time in the UK (Bebbington et al. 2012; KPMG 2011, p. 10, 2013, p. 23, 2015, p. 33). With respect to media, firms have on average 52 negative sustainability-related newspaper articles per year, with a minimum of zero and a maximum of 23,767 articles (original, untransformed values).[22] With respect to the control variables, *gri* indicates that 24 percent of the observations provide their sustainability disclosures according to the GRI guidelines. The original values of *report_length* (untabulated) indicate that the average report comprises 77,589 words. On average, the sample firms have 33 million GPD in assets (original values untabulated), a relatively high return on assets of 20% and leverage of 0.20.[23]

Regarding the textual measures *gender_KPI* and *ghg_KPI*, we manually check the validity of the findings. Overall, the search query appears to be appropriate in identifying the required information. In the Appendix, we provide examples of incorrect classifications. For instance, our search query might not correctly identify the reported information when one of the search terms appears in the text and one of the search terms appears in a table or both search terms appear in a table. In this case, the search terms might not appear within the five-word window. In other instances, the search query loads, although including the required information, are not reported, such as when year dates are identified as numeric expression without directly specifying the amount of GHG emissions or number of female employees.

Panel B of Table 4 reports the mean values and standard deviation for the disclosure variables for each reporting year and the sample of treated versus control firms separately. For the sample of treated firms, reporting on the mandated key performance indicators is already high before 2013, i.e., before the regulation took effect. In 2010, 78 percent of the firms provide quantitative information on their GHG emissions; this figure increases to 85 percent in 2013. With respect to information on gender distribution, only 16 percent of the firms disclose this

[22] The maximum of 24,241 articles refers to BP in 2010.
[23] Note that despite winsorization, the maximum value for roa equals 3.58.

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information in 2010, compared to 65 percent in 2013. Thus, there is a high level of compliance with the regulations, but there are still firms that do not provide the mandated information, which is in line with Glaum et al. (2013); Larrinaga et al. (2002); Peters and Romi (2013). Remarkably, the peak is in 2014, followed by a slight decrease in 2015. The data on the narrative disclosure provide a similar picture. The data reveal a steady increase in *ghg_narrative*, *gender_narrative* and *hr_narrative* until 2014 and a drop in the data in 2015. For the sample of matched firms, disclosure on the key performance indicators is low and does not substantially change over time. On average, approximately 10 percent of the firms publish quantitative information on their GHG emissions, and only approximately 0.5 percent of the firms publish the gender distribution. With respect to the narrative disclosure measures, the mean values are substantially lower for the sample of control firms than for the sample of treated firms. Similar to the treatment group, there is a steady increase in the mean values of the narrative disclosure measures over time.

Panel C of Table 4 provides an overview of the twenty most frequent words along with their frequency in the retrieved ten-word windows, i.e., the topic vocabularies.[24] These words provide some intuition regarding the validity of our disclosure measures. With some exceptions, for instance, the words "year" and "report" in the vocabulary for the disclosure measure *gender_narrative*, the words appear to capture the mandated topics appropriately.

Insert Table 4 about here

4.2 Bivariate Statistics

Table 5 presents the correlation statistics for the regression variables. All of the disclosure measures are positively and significantly correlated with each other, indicating that narrative disclosure accompanies disclosure on the mandated key performance indicators and disclosure on GHG emissions accompanies disclosure on gender distribution and human rights and vice versa. All of the disclosure measures are positively and significantly correlated

[24] Note that the frequency refers to the occurrence of the words in the topic vocabularies, not in the annual reports. Because of the construction of the windows, the same word might appear more than once in the vocabulary if the word window is composed of more than one search term.

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with both post and treated, indicating that disclosure is higher in the period when the SR Regulations became effective and among treated firms. Moreover, except for *governance*, our proxies for reporting incentives are positively correlated with all the disclosure measures. In addition, except for *governance* and *prior_discl*, the proxies for reporting incentives are not correlated with *treated* and none of the proxies is correlated with *post*. With respect to the control variables, *report*_length is positively correlated with all disclosure measures thereby indicating that longer reports provide more disclosure on the mandated topics. *gri* is also positively related to all disclosure measures except *gender_narrative,* thereby indicating that firms that follow the GRI guidelines are more likely to provide information on GHG emissions and gender distribution and provide more narrative information on GHG emissions and human rights. Finally, *roa* is positively related to the disclosure measures, whereas the coefficients for *size* and *lev* are ambiguous and not significant.

Insert Table 5 about here

Table 6 presents the results from univariate difference-in-differences analyses. Specifically, we compute the difference in our disclosure variables between pre-period and post-period for the treated and control firms and compare the difference in these differences. For the sample of treated firms, the results reveal a significantly higher disclosure level for all disclosure measures in the period after the adoption of the SR Regulations. For control firms, the results reveal no significant differences in the disclosure measures between the preadoption and the postadoption periods of the SR Regulations with respect to the disclosure of the key performance indicators as well as narrative disclosure on GHG emissions. However, firms in the control sample provide significantly more narrative information on gender distribution and human rights in the period of 2013-2015 than in the period of 2010-2012. In addition, this increase is significantly larger for the treated firms compared to the control firms, as indicated by the difference-in-differences estimators.

Insert Table 6 about here

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4.3 Regression Analyses

Table 7 documents the findings of the regression analyses for examining our research questions. We present model specifications with year-fixed effects and standard errors clustered at the firm level.

Insert Table 7 about here

With respect to our first research question, i.e., the treatment effect, the coefficients of interest are β_2 (*postxtreated*) and the sum of β_2 (*postxtreated*) and β_6 (*postxtreatedxincentive*). The findings reveal positive and significant coefficients for our difference-in-difference estimator β_2 across all disclosure measures and reporting incentives, with only one exception (*hr_narrative* and *prior_discl*). Thus, in case of low reporting incentives, the increase in disclosure among treated firms after the implementation of the SR Regulations is significantly greater than that among firms in the control group. We obtain similar findings in case of high reporting incentives, i.e., the sum (β_2 + β_6) is positive and significant in almost all regressions.[25] This result is consistent with the findings of Ioannou and Serafeim (2017) but not with those of (Bebbington et al. 2012; Chauvey et al. 2015; Fallan and Fallan 2009; Larrinaga et al. 2002; Peters and Romi 2013).

It is important to highlight that the change in disclosure pertains to all disclosure topics. Although the SR Regulations are relatively modest in mandating sustainability disclosure, the results show that even such a modest regulation can induce an increase in disclosure. Specifically, the results show an increase not only in the disclosure of the mandated key performance indicators for which the phrasing of the regulation and the disclosure itself is very precise and specific but also in the narrative disclosure measures. This increase in narrative disclosure is not limited to accompanying disclosure on the mandated key performance indicators but also includes disclosure on human rights issues. In the robustness section of the paper, we therefore examine additional spillover effects and test whether the disclosure increase also relates to other dimensions of sustainability. Nevertheless, despite this

[25] Except for *ghg_narrative* and *analysts*, *hr_narrative* and *growth*, *hr_narrative* and *governance*, *ghg_KPI* and *prior_discl*, and *hr_narrative* and *prior_discl*.

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significant increase in disclosure, there are still firms that do not provide the mandated information (see section 4.1). Next, we are therefore interested in whether reporting incentives shape firms' responses to SR Regulations.

Insert Table 7 about here

With respect to our second research question (RQ2), we first examine the selection effect, i.e., the role of reporting incentives in a voluntary setting. Overall, firm-level reporting incentives tend to be positively associated with the disclosure measures in a voluntary setting as indicated by β_3, (β_3+β_5) and (β_4+β_4). That means that in a voluntary setting, firms with higher reporting incentives provide higher disclosure levels, i.e., the selection effect. With respect to the compliance effect, we find some evidence for a negative effect for capital market visibility, corporate governance mechanisms and prior voluntary sustainability disclosure level.[26] Thus, the incremental effect of high reporting incentives on the treatment effect of the SR Regulations is negative, which suggests that reporting incentives partially mitigate the treatment effect. However, it is important to note that the overall treatment effect (i.e., β_2+β_6) remains positive. Below, we discuss our findings for the reporting incentives in more detail.

With respect to capital market visibility, the results reveal a positive effect of capital market visibility on all disclosure measures in a voluntary setting.[27] Thus, firms with higher capital market visibility have higher reporting incentives to reduce information asymmetries and avoid the adverse selection problem. Even in a mandatory setting, the positive relationship between capital market visibility and disclosure holds (β_3+β_4+β_5+β_6). This finding is consistent with Bassemir and Novotny-Farkas (2018), who report that capital market-oriented firms exhibit significantly higher accounting quality in the postadoption period. However, the positive selection effect partially mitigates the treatment effect. As a consequence, the incremental effect of capital market visibility on the treatment effect (the triple interaction β_7) is negative for *ghg_KPI* and *ghg_narrative*, which means that the increase in disclosure on

[26] For *growth,* the triple interaction is positive. For *media*, the triple interaction is not significant.
[27] (β_3+β_5) is positive and significant for all disclosure measures and (β_3+β_4) is positive and significant for some disclosure measures.

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GHG emissions after the SR Regulations is smaller for firms with high capital market visibility.

For growth orientation, the results are much weaker than for capital market visibility. There are some indications of a positive selection effect with respect to *gender_KPI* (β_3 and $\beta_3+\beta_4$), *gender_narrative* (β_3 and $\beta_3+\beta_4$) and *hr_narrative* ($\beta_3+\beta_4$ and $\beta_3+\beta_5$), but not for *ghg_KPI* and *ghg_narrative*. Growth firms have higher external financing needs and thus have more incentives to reduce the costs of external financing through increased disclosure. This relationship also holds for the mandatory setting with respect to *gender_narrative* and *hr_narrative* (i.e., ($\beta_3+\beta_4+\beta_5+\beta_6$) is positive and significant), which is in accordance with the results provided by Verriest et al. (2013) and Bassemir (2018). In addition, we obtain a positive and significant compliance effect for *gender_narrative*, thereby suggesting a complementary relationship between growth orientation and the regulatory intervention. In other words, growth firms increase the narrative disclosure on gender distribution in response to the regulatory intervention more than other firms. Note that this is the only reporting incentive for which we find a positive compliance effect.

With respect to corporate governance mechanisms, we also find some evidence for a positive effect on the disclosure measures in a voluntary setting.[28] Strong corporate governance mechanisms enhance the monitoring of managers, thereby reducing the benefits of withholding information, which results in a disclosure increase. The finding is thus in line with the literature and also partly holds for a mandatory setting (*ghg_KPI* and *ghg_narrative*). However, β_3 is negative and significant with respect to *gender_KPI*, thereby indicating that on average, US firms with stronger corporate governance mechanisms provide less information on gender distribution. With respect to the compliance effect, the triple interaction is negative and significant for *gender_narrative*, thereby suggesting a negative incremental effect of corporate governance mechanisms on the treatment effect. This negative effect is consistent with the findings of Ernstberger and Grüning (2013), who provide evidence that the positive association between corporate governance and disclosure is particularly prevalent in countries with weak regulatory environments.

[28] More precisely, ($\beta_3+\beta_4$) is positive and significant for *ghg_KPI* and *gender_KPI* and ($\beta_3+\beta_5$) is positive and significant for *gender_KPI*, *ghg_narrative* and *gender_narrative*.

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For firms' prior voluntary sustainability disclosure level, the results reveal a positive effect on all disclosure measures in both a voluntary and a mandatory setting ($\beta_3+\beta_4+\beta_5+\beta_6$). These findings indicate that firms with higher prior voluntary sustainability disclosure levels are more likely to disclose the key performance indicators and to provide narrative information on GHG emissions, gender distribution and human rights in their annual reports. In addition, we obtain a negative triple interaction for *ghg_KPI*, thereby indicating that the positive selection effect partially mitigates the treatment effect. This finding contrasts with Ioannou and Serafeim (2017) who find a treatment effect for firms with both high and low prior voluntary sustainability disclosure levels.

Finally, our results suggest that the role of media coverage is only marginal in our setting. There is loose evidence suggesting a negative effect of media coverage in a voluntary setting among US firms (β_3), but positive effects among UK firms in the pre-regulatory period ($\beta_3+\beta_5$). In addition, the triple interaction is not significant for none of the disclosure measures. Thus, legitimacy concerns, which sustainability disclosure research has identified as important drivers of voluntary disclosure, are not associated with the disclosure of sustainability information in annual reports and do not alter changes in disclosure in the event of a regulatory intervention. In other words, firms do not use sustainability disclosure in annual reports to close potential legitimacy gaps or even to manipulate stakeholders' perceptions. One potential reason might be that the disclosure medium of the annual report particularly matches the needs of capital market participants, whereas the broad group of other stakeholders is more likely to consider other disclosure channels, such as company websites and standalone sustainability reports. Of course, our findings are restricted to the disclosure on the mandated topics, and firms might respond to legitimacy gaps by increasing their disclosures on other topics.

5 Robustness and Additional Analyses

5.1 Alternative Model Specifications

We conduct numerous additional analyses to further investigate our findings. First, we address the concern that our findings could be driven by systematic differences in the sample firms. For that reason, we rerun the analyses and include firm-fixed effects. The results remain substantially unchanged (untabulated). In particular, the treatment effect (*postxtreated*) remains positive and significant across all model specifications, while the incentive effect

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(*postxtreatedxincentive*) is negative and significant for some of the model specifications (similar to our baseline results). Next, we investigate whether firms' sustainability performance confounds our findings. In a voluntary setting, the literature documents that superior sustainability performers in particular disclose accurate and comparable sustainability information to signal their superior performance type to the capital market (Clarkson et al. 2008; Clarkson et al. 2011; Hummel and Schlick 2016). Therefore, one may argue that superior sustainability performers are more likely to provide specific sustainability information. We rerun the regression analyses including the overall sustainability performance rating of the ThomsonReuters Asset4 database to proxy for firm sustainability performance. Because of missing values on the sustainability performance variable, our sample is reduced to 2,175 observations. Overall, the main findings hold. Specifically, β_2 (*postxtreated*) remains positive and significant for all models, and the results from our baseline specification for β_5 (*postxtreatedxincentive*) hold. In addition, the coefficient for sustainability performance is positive and significant in almost all models. Thus, sustainability performance is positively associated with sustainability disclosure, which tends to support the traditional reasoning of voluntary disclosure theory.[29] Second, we examine the validity of our findings by constructing placebo events. For that purpose, we construct a new variable that replaces the variable *post,* thereby shifting backward the year for which the regulation becomes effective. More precisely, *placebo12xtreated* equals "1" beginning in 2012 onwards, and "0" otherwise. If our interpretation of the results is valid, we would expect to find insignificant estimated coefficients for *placebo12xtreated*. Note that we focus on the treatment effect only. Contrary to our expectations, the coefficients for *placebo12xtreated* are still positive and significant, thereby indicating that there might be anticipatory effects, i.e., firms might have adapted their disclosure even before 2013. To dig deeper into this finding, we replace *postxtreated* by separate interaction terms for each year, i.e., *2011xtreated*, *2012xtreated*, *2013xtreated*, *2014xtreated* and *2015xtreated*. The results show a steady increase in disclosure on information on gender issues (both *gender_narrative* and *gender_KPI*) in the treatment group relative to the control group for the whole period of analysis, with increasing coefficients for *yearxtreated*. For the other disclosure variables, the results show that the increase in disclosure among the treated firms relative to the control firms becomes significant, particularly for the years after the regulation became effective, i.e., in 2013/2014 (*ghg_narrative, hr_narrative*) or 2014/2015 (*ghg_KPI*).

[29] For a thorough debate on the relationship between sustainability performance and sustainability disclosure, see Hummel and Schlick (2016).

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Insert Table 8 about here

With respect to the reporting incentives, we disaggregate the factor variable *governance and* examine each variable separately. In contrast to the main findings, we now obtain insignificant coefficients for the triple interactions. Next, instead of examining the firm's prior level of sustainability disclosure, we examine the firm's prior level of sustainability performance as a moderating variable. The results remain substantially the same compared to the baseline specification with *prior_discl* as moderating variable (note that the sample size is reduced to 2,107 observations). Because of the high correlation between these two measures, the moderating effects appear to stem from a firm's overall sustainability orientation, not only from a firm's overall level of sustainability disclosure. With respect to negative media coverage, we disaggregate the score into the components "environmental" and "social and human rights". The results remain unchanged.

5.2 Alternative Disclosure Measures and Textual Attributes

With respect to our disclosure measures, we investigate several alternative constructions. For the measurement of *ghg_KPI*, we additionally require the exclusion of "no" and "not" from the five-word windows.[30] For that purpose, we have to rerun the preprocessing procedures, as these words were originally defined as stop words. The measures remain almost identical and thus, our main results do not change. Next, we are interested in whether treated firms increase their disclosure not only on the mandated sustainability topics but also on sustainability in general. Therefore, we construct disclosure measures based on the sustainability dictionary developed by Pencle and Mălăescu (2016). In an iterative process, the authors develop a dictionary of words that are typically used to describe the sustainability dimensions of environment, employee and human rights. Our disclosure measures *count_ENV*, *count_EMPL*, and *count_HR* are calculated based on the number of words in each report that correspond with the words listed in the dictionary divided by the total number of words. In addition, we include *count_SOCIAL,* which is calculated based on the word counts for the

[30] By allowing for the occurrence of "no" and "not" in the five-word windows, one may argue that we might capture statements such as "The company emits 0 tons of CO2".

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social dimension. It is important to note that the dictionary attempts to capture the complete environmental, employee, and human rights dimension, whereas our topic-specific narrative disclosure measures focus on the mandated topics, which comprise only specific aspects of these sustainability dimensions. In addition, the use of word counts and dictionary-based measures comes at a certain expense. Specifically, the dictionary itself needs to be valid. Such dictionaries typically are composed of a considerable number of words with ambiguous meanings, which may confound the validity of the measurement.[31] Although the dictionary is validated by experts, the inclusion of some of the words is questionable.[32] Moreover, the dictionary was developed based on 10-K statements of US firms and thus, the resulting words might be biased toward US language.[33] Finally, the usual shortcomings of word count-based measures apply.[34]

Insert Table 9 about here

Panel A of Table 9 provides Pearson correlation coefficients for the sample of treated firms. The results reveal significantly positive correlations between the window-based narrative disclosure measures on the mandated topics and the word count-based disclosure measures. The correlations range in the interval between 0.30 (for *hr_narrative* and *count_HR*) and 0.42 (*ghg_narrative* and *count_ENV*), thereby indicating some but not complete overlap between the topic-specific measures and the word count-based measures for the corresponding sustainability dimension. Next, we run OLS regression analyses for equation (1) and for a model without the moderating variables. For convenience reasons, Panel B of Table 9 displays the results from the latter model for the word count-based measures. The results indicate a significant increase in disclosure among treated firms for the employee and human rights dimension but not for the environmental and social dimension, thereby indicating that

[31] For instance, the dictionary provided by Pencle and Mălăescu (2016) includes 319 words for the employee dimension, 451 words for the environmental dimension, and 297 words for the human rights dimension.
[32] Examples include the words "balancing", "certification", "agent", "award", "died", "election", "law", "outsourcing", "personal", "person" or "worker" in the human rights dimension and the words "country", "innovation", "reasonable", "science", "suitable", and "voluntary" in the environmental dimension.
[33] Typical US words are, for instance, "EPA" and "environmental protection agency" in the environmental dimension, "African American" in the employee and human rights dimension, and "first nation" in the human rights dimension.
[34] Specifically, the use of word counts implies that each word receives the same weight, although adjustments based on how unusual the word is typically enhance the validity of the measure (Loughran and McDonald 2016).

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potential spillover effects from the regulation towards disclosure of other sustainability dimension are limited.

Finally, we are interested in whether the regulation affects other textual attributes, namely, tone, readability, numerical content and report length. Recently, Muslu et al. (2017) aggregated these textual attributes into a sustainability disclosure measure and show a positive relationship with analyst forecast accuracy. In the context of mandatory sustainability disclosure regulation, prior research has often examined the reporting of good versus bad news as a potential consequence of mandatory disclosure regulations (Chauvey et al. 2015; Costa and Agostini 2016; Larrinaga et al. 2002). In general, mandatory disclosure regulations aim to increase disclosure *regardless* of the actual performance of a company. Compared to a voluntary reporting regime, we would thus expect to find either no change or an increase in the disclosure of negative information after the regulatory intervention in the treatment group versus the control group. However, prior research has documented a decrease in bad news reporting after regulatory interventions (Chauvey et al. 2015; Costa and Agostini 2016). *tone* is measured as the number of positive words minus the number of negative words divided by the total number of words.[35] We caution our readers that tone is a crude measure that gauges the sentiment of the text and not the content of the information, i.e., whether bad or good news is reported. In addition, we examine the readability of the reports, i.e., "whether the receiver of information can accurately reconstruct the intended message" (Loughran and McDonald 2016). In the context of financial disclosure, empirical evidence suggests a positive relationship between the readability of firms' financial disclosure and market efficiency (Biddle et al. 2009; Lo et al. 2017; Loughran and McDonald 2014). In the context of sustainability disclosure, empirical evidence suggests a positive relationship between financial and sustainability performance and readability (Melloni et al. 2017; Nazari et al. 2017). Better performing firms provide more readable reports to signal their superior performance, whereas poorly performing firms provide less readable reports as part of an obfuscation strategy. We therefore expect the reports to become more readable because of the regulatory intervention. *readability* is measured based on an aggregation of the Fog Index, Flesch-Kincaid and Flesch Reading Ease, multiplied by (-1) (De Franco et al. 2015; Hummel

[35] Positive and negative words are defined according to a word list provided by Loughran and McDonald (2011).

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et al. 2017).[36] Next, we also examine the accuracy of the report based on its numerical content. It is often argued that numerical information is more accurate, objective, comparable and verifiable (Clarkson et al. 2008; Clarkson et al. 2011). Muslu et al. (2017) show higher analyst forecast accuracy for sustainability reports that contain more numerical content. However, since the regulation mandates both quantitative and narrative disclosure, the effect on the proportion of numerical content in reports is unclear. We measure numerical content based on *ratio_numbers,* which is defined as the proportion of Arabic numerals over the total number of words.[37] Finally, we are also interested in whether the overall length of the annual report (*report_length*) changes because of the adoption of the SR Regulations. While Loughran and McDonald (2014) argue that file size can serve as an inverse proxy for readability, as managers provide longer and more complex reports for obfuscation reasons, other researchers argue that longer reports simply provide more information than shorter reports (Li 2008; Muslu et al. 2017). In the context of sustainability disclosure, Nazari et al. (2017) show that the length of a firm's standalone sustainability report is positively associated with sustainability performance. Since the SR Regulations require additional disclosure, we expect an increase in report length when the regulation became effective. The results are displayed in Panel C of Table 9. Again, we report the results for the parsimonious model, i.e., without the moderating effects. With respect to tone, the results show that the tone of the UK annual reports is more positive than that of the US annual reports, which might be related to the stricter format of the 10-K statements. However, there is no significant change in tone in response to the regulation. With respect to the other textual characteristics, the results reveal a significant decrease in readability among US firms and a significant increase in readability among UK firms after the regulation. Similar findings are obtained for the numerical content and the length of the reports, which also significantly increase after the regulation among UK firms relative to US firms. Taken together, the results suggest that the UK reports become longer and more readable and contain more numerical content after the adoption of the SR Regulations, while the tone of the reports remains unchanged.

[36] Higher values thus reflect better readability of the text. The measures are calculated based on the average number of words per sentence (w), the percentage of complex words relative to all words (p) and the average number of syllables per word (s):
Fog Index = 0.4 *(w+p); Flesch-Kincaid=11.8s+0.39w-15.59; Flesch Reading Ease=206.8-1.015w-84.6s.
[37] Note that we transform numbers separated by "," or "." into a single token. Nevertheless, our measure is noisy since we cannot exclude page numbers, chapter numbers and figure numbers.

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6 Conclusions

This paper investigates the consequences of the introduction of the Companies Act 2006 Regulations 2013 on firms' disclosure of sustainability information in their annual reports. The regulation mandates the disclosure of key performance indicators, namely, the amount of GHG emissions and the distribution of gender across different employee categories, along with the disclosure of general information on human rights issues. We are interested in two research questions: first, whether UK firms on average increase their disclosure on the mandated topics after the regulation took effect relative to a control group of US firms (treatment effect); and second, whether this increase in disclosure is moderated by firm-level reporting incentives that prior research has identified to be significant in a mandatory setting (compliance effect).

To measure disclosure on the mandated topics, we use computer-assisted textual analysis. This allows us to conduct precisely defined analyses of firm disclosures for large sample sizes and thus to overcome typical limitations in sustainability disclosure research. We focus on two types of disclosure, namely, disclosure of key performance indicators and narrative information on the mandated topics. To identify whether firms disclose the mandated indicators, we define specific search queries. For the measurement of firms' narrative disclosure on the mandated topics, we rely on a methodology that was originally developed by Hoberg and Maksimovic (2015) and has been adapted by Hummel et al. (2017).

Our sample consists of firms listed in the FTSE-350 index and a matched control group of US firms. To investigate our research questions, we use a triple-difference design. Specifically, with respect to our first research question, we examine the change in disclosure for the treated group relative to the control group for both high and low reporting incentives. With respect to our second research question, we are interested in the incremental change in the treatment effect attributable to firm-level reporting incentives. Our results reveal a positive and significant increase in disclosure among the treated firms relative to a control group after the regulation became effective. This finding pertains to all disclosure measures, including key performance indicators and narrative disclosure. With respect to our second research question, the results reveal that capital market visibility, growth orientation, corporate governance mechanisms and a firm's prior voluntary sustainability disclosure level partly moderate the increase in disclosure after the regulation. Specifically, we find a negative triple interaction for these reporting incentives except for growth orientation, thereby indicating that stronger

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reporting incentives mitigate the treatment effect. For growth orientation we find a complementary effect. We do not find any evidence that negative media coverage is associated with this disclosure increase. In the robustness section of the paper, we provide additional insights into how traditional textual attributes are affected by the regulation. The results show a significant increase in the readability, numerical content and overall length of the annual reports.

As always, the results of our study are subject to limitations. First, we caution our readers not to over-interpret our findings, since we performed rather an association study than a causal study. Specifically, we do not claim to fully solve the endogeneity problem with our research design. Instead, the paper provides large-sample empirical evidence on the disclosure of sustainability information in annual reports around the adoption of new regulations. We thus provide rich descriptive evidence in line with Gow et al. (2016), who call for more descriptive studies in accounting and a deeper investigation of accounting as an "applied discipline". Based on our empirical evidence, future studies might be more concerned with the endogeneity problem. Second, the focus on a national regulatory intervention limits the generalizability of the findings because of the existence of country-specific regulations and institutions. Thus, our results need to be interpreted against the background of the SR Regulations. In addition, the dual-country setting does not allow us to account for institutional factors, which have been shown to shape reporting incentives in the contexts of both financial disclosure (Ball et al. 2000; Ball et al. 2003; Burgstahler et al. 2006; Daske et al. 2008, 2013) and sustainability disclosure (Cahan et al. 2016; Dhaliwal et al. 2014; Dhaliwal et al. 2012). The recent adoption of the EU Directive on nonfinancial disclosure offers a promising research setting for future studies to examine the role of institutional factors in the context of nonfinancial disclosure. Of particular interest is how interactions between firm- and country-level factors turn out in a sustainability disclosure setting. Third, the usual limitations of textual analysis apply (Loughran and McDonald 2016). Because of the novelty of textual analysis in accounting research, the methodologies are still in a developmental stage, and empirical evidence on their use is therefore scarce. Our paper introduces and adapts one methodology that can be used to measure narrative topic-specific disclosure in annual reports. By providing detailed descriptions of the textual analysis, we aim to increase the transparency and replicability of our findings. In addition, examples and results from additional analyses and robustness checks further support the validity of our findings. Finally, the study does not examine the "real" effects of this disclosure regulation, i.e., the consequences for firms'

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performance with respect to the mandated sustainability topics, although improvements in firms' sustainability performance are often mentioned as a regulatory objective in this context (Directive 2014/95/EU ; Leuz and Wysocki 2016, p. 527). Future research could provide in-depth evidence on these effects in terms of both firm sustainability performance and capital market effects, thereby extending the findings, which are currently primarily limited to sustainability disclosure in a voluntary setting.

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Table 1: Sample selection and composition by industry

Panel A: Sample selection	
FTSE-350 firms (350 firms, 6 reporting years)	2,100
Less: observations with missing annual reports	-284
Less: observations for which the reports cannot be processed	-342
Less: observations with missing control variables	-232
Sample of treated firms:	**1,242**
Matched sample of US firms (198 firms, 6 reporting years)	1,175
Sample of treated and matched firms:	**2,417**

Panel B: Sample distribution by year	***treated***	***matched***	***Total***
2010	189	190	379
2011	193	193	386
2012	201	198	399
2013	209	198	407
2014	221	198	419
2015	229	198	427
Total sample:	**1,242**	**1,175**	**2,417**

Panel C: Sample distribution by industry		***treated***	***matched***	***Total***
1	Mining and construction	135	92	227
2	Manufacturing	338	331	669
3	Transportation and public utilities	150	132	282
4	Wholesale and retail trade	170	159	329
5	Finance, insurance and real estate	288	284	572
6	Services	161	177	338
Total sample:		**1,242**	**1,175**	**2,417**

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Table 2: Variables overview

Variable	Description	Source of data
Dependent variables for sustainability disclosure		
ghg_KPI	Binary variable indicating whether the report discloses the key performance indicator "quantity of GHG emissions"; the corresponding search query is displayed in Table 3.	Textual analysis
gender_KPI	Binary variable indicating whether the report discloses the key performance indicator "gender distribution"; the corresponding search query is displayed in Table 3.	Textual analysis
ghg_narrative	Cosine similarity of the vocabulary of each report with a vocabulary that reflects the mandated topic of GHG emissions. The vocabulary is constructed based on an aggregation of ten-word windows that are retrieved according to a search query displayed in Table 3.	Textual analysis
gender_narrative	Cosine similarity of the vocabulary of each report with a vocabulary that reflects the mandated topic of gender distribution. The vocabulary is constructed based on an aggregation of ten-word windows that are retrieved according to a search query displayed in Table 3.	Textual analysis
hr_narrative	Cosine similarity of the vocabulary of each report with a vocabulary that reflects the mandated topic of human rights. The vocabulary is constructed based on an aggregation of ten-word windows that are retrieved according to a search query displayed in Table 3.	Textual analysis
Main variables of interest		
post	Dummy variable that equals "1" beginning in the year the SR Regulations became effective (2013) and "0" otherwise.	Datastream Worldscope
treated	Dummy variable that equals "1" if a firm is domiciled in the "treatment" country, i.e., the UK, and "0" otherwise.	Datastream Worldscope
Reporting incentives		
analysts	Binary variable that equals 1 if the number of analysts following a firm is above the sample median in the respective year and 0 otherwise.	I/B/E/S
growth	Binary variable that equals 1 if the market-to-book ratio is above the sample median in the respective year and 0 otherwise.	Datastream Worldscope
governance	Binary variable that equals 1 if the strength of firm's corporate governance mechanisms is above the sample median in the respective year and 0 otherwise. The strength of a firm's governance mechanisms is measured as the factor with the highest eigenvalue derived from a principal component analysis on the following standardized variables: board1 (whether the board has a policy for maintaining effective board functions), board2 (whether the company has a corporate governance board), board3 (whether the company has an audit committee board) and board4 (the percentage of independent directors).	Bloomberg, ASSET4
prior_discl	Binary variable that equals 1 if the firm's prior sustainability disclosure level is above the sample median in the respective year and 0 otherwise. The firm's prior sustainability disclosure level is measured as the Bloomberg ESG disclosure score in the prior year.	Bloomberg
media	Binary variable that equals 1 is the number of negative media articles is above the sample median in the respective year and 0 otherwise. The number of negative media articles is measured as the number of articles that load for each firm-year and a given set of international newspapers on the following query in the Factiva database: Search query for environmental topics: ((ECOLOGY or EMISSION or WATER or ENVIRONMENTAL or OIL or WASTE or (PALM and OIL) or (NUCLEAR and POWER) or ENERGY) and (LEAK or	Factiva

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	CONTROVERSY or DAMAGE or CRITICISM or RECALL or VIOLATION or crisis)) or POLLUTION or (LAND and CONTAMINATION) or (OIL and SPILL) or (WASTE and DISCHARGE) or (TOXIC and WASTE) or CONTAMINATION or ASBESTOS. Search query for social and human rights topics: ((POOR or UNSAFE or UNFAIR) and (WORK or WORKING or EMPLOYMENT)) or (CHILD and LABOR) or (WORKER and DEATH) OR (SEXUAL and EXPLOITATION) or (LAND and GRAB) or (((TRADE and UNION) or WORKER or WORK OR LABOR or (HUMAN and RIGHT)) and (ABUSE or DISCRIMINATION or SUPPRESSION or REPRESSION or VIOLENCE OR CRTICISM or CONTROVERSY or DEATH or VIOLATION)).	
Control variables		
gri	Dummy variable that equals "1" if the firm reports according to the GRI sustainability reporting guidelines, and "0" otherwise.	Bloomberg
report_length	Length of the annual report, measured as the natural logarithm of the total number of words.	Textual analysis
size	Firm size, measured as the natural logarithm of total assets at fiscal year-end, winsorized at the top and bottom 1%.	Datastream Worldscope
roa	Return on assets, measured as net income divided by total assets at fiscal year-end, winsorized at the top and bottom 1%.	Datastream Worldscope
lev	Financial leverage of the firm measured as total debt divided by total assets at fiscal year-end, winsorized at the top and bottom 1%.	Datastream Worldscope

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Table 3: Overview of the search queries for the construction of the disclosure measures

Topic	Search query	Window size	Score
ghg_KPI	(“tonne” OR “ton” OR “numeric”) AND (“GHG” or “*CO2*” OR “carbon” OR (“greenhouse” AND “gas”))	5 words	binary score that reflects the presence (=1) versus absence (=0) of the information
gender_KPI	((“female” OR “gender” OR “woman” or “sex”) AND (“board” OR “director” OR “executive” OR “manager” or “employee”) AND “numeric”) OR ((“gender” AND “distribution”) OR (“gender” AND “split”) OR (“gender” AND “breakdown”) AND “numeric”)	5 words	binary score that reflects the presence (=1) versus absence (=0) of the information
ghg_narrative	(“ghg” AND “emission”) OR (“*CO2*” AND “emission”) OR (“carbon” AND “dioxide”) OR (“greenhouse” AND “gas”) OR (“climate” AND “change”) OR (“kyoto” AND “protocol”) OR (“global” AND “warming”)	10 words	continuous score based on the cosine similarity of each report with the words in the vocabulary
gender_narrative	(“gender” AND “split”) OR (“gender” AND “diversity”) OR (“gender” AND “distribution”) OR (“gender” AND “breakdown”) OR (“female” AND “manager”) OR (“woman” AND “manager”) OR (“female” AND “management”) OR (“woman” AND “management”) OR (“female” AND “director”) OR (“woman” AND “director”) OR (“female” AND “executive”) OR (“woman” AND “executive”) OR (“female” AND “board”) OR (“woman” AND “board”)	10 words	continuous score based on the cosine similarity of each report with the words in the vocabulary and
hr_narrative	(“human” AND “right”)	10 words	continuous score based on the cosine similarity of each report with the words in the vocabulary

“numeric” refers to Arabic numerals or quantitative words
* denotes a wildcard

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Table 4: Descriptive statistics

Panel A: Descriptive statistics for regression variables for the sample of treated and matched firms						
	mean	***sd***	***min***	***median***	***max***	***obs***
ghg_KPI	0.4853	0.4999	0.0000	0.0000	1.0000	2,417
gender_KPI	0.2751	0.4467	0.0000	0.0000	1.0000	2,417
ghg_narrative	1.7204	1.5791	0.0000	1.3413	11.3771	2,417
gender_narrative	0.8744	0.8689	0.0000	0.5251	5.2856	2,417
hr_narrative	1.2678	0.8381	0.0000	1.0992	4.9823	2,417
post	0.5184	0.4998	0.0000	1.0000	1.0000	2,417
treated	0.5139	0.4999	0.0000	1.0000	1.0000	2,417
analysts (original)	15.66487	8.354534	0.0000	15.0000	44.0000	2417
growth (original)	1.1287	1.1724	0.0100	0.8189	17.5935	2,417
governance (original)	0.0000	1.0000	-2.0425	-0.4502	1.5380	2,417
prior_discl (original)	30.4625	13.7369	6.1983	28.5124	75.6198	2,417
media (original)	52.04179	522.8513	0.0000	6.0000	23,767	2417
gri	0.2429	0.4289	0.0000	0.0000	1.0000	2,417
report_length	11.1240	0.6417	0.0000	11.1260	12.7485	2,417
size	8.2825	1.7830	4.5148	8.0596	13.9977	2,417
roa	0.2084	0.3515	0.0000	0.1314	3.5798	2,417
lev	0.2049	0.1707	0.0000	0.1803	0.8818	2,417
Panel B: Descriptive statistics for the disclosure variables by year						
treated=1						
	2010	***2011***	***2012***	***2013***	***2014***	***2015***
ghg_KPI	0.7831	0.7513	0.7463	0.8517	0.9276	0.9039
	(0.4133)	(0.4334)	(0.4362)	(0.3563)	(0.2597)	(0.2953)
gender_KPI	0.1587	0.3161	0.4080	0.6459	0.7738	0.7729
	(0.3664)	(0.4661)	(0.4927)	(0.4794)	0.4193)	(0.4199)
ghg_narrative	2.3792	2.4010	2.4783	2.7834	2.8968	2.6538
	(1.6794)	(1.6745)	(1.6867)	(1.7138)	(1.5778)	(1.4220)
gender_narrative	0.9761	1.2887	1.4452	1.6683	1.7912	1.6720
	(0.4927)	(0.7756)	(0.7912)	(0.8514)	(0.8114)	(0.7948)
hr_narrative	1.5975	1.6804	1.7331	1.8547	1.9274	1.8324
	(0.6867)	(0.7703)	(0.7340)	(0.8232)	(0.7671)	(0.7320)
treated=0						
	2010	***2011***	***2012***	***2013***	***2014***	***2015***
ghg_KPI	0.1053	0.1399	0.1263	0.1263	0.1162	0.1010
	(0.3077)	(0.3478)	(0.3330)	(0.3330)	(0.3212)	(0.3021)
gender_KPI	0.0053	0.0052	0.0051	0.0101	0.0101	0.0101
	(0.0725)	(0.0720)	(0.0711)	(0.1002)	(0.1002)	(0.1002)
ghg_narrative	0.7252	0.7491	0.7877	0.7890	0.7939	0.8367
	(0.7631)	(0.7601)	(0.8085)	(0.8277)	(0.7240)	(0.7531)
gender_narrative	0.2018	0.2109	0.2126	0.2200	0.2355	0.2569
	(0.1561)	(0.1837)	(0.1642)	(0.1733)	(0.1871)	(0.1807)
hr_narrative	0.6529	0.6889	0.7259	0.7521	0.7531	0.7951
	(0.4371)	(0.5385)	(0.4987)	(0.5295)	(0.5155)	(0.5683)

Panel C: Overview of the twenty most frequent words in the topic vocabularies

ghg_narrative	emission (40734), energy (30939), gas (24885), greenhouse (23165), change (20240), climate (19313), ghg (13931), renewable (12805), efficiency (10782), carbon (9431), reduction (6051), regulation (5222), dioxide (5108), scope (4947), impact (4445), global (4442), fuel (4076), including (3977), report (3927), environmental (3783)
gender_narrative	diversity (6779), gender (6079), female (2466), director (2264), woman (1421), management (1117), include (985), male (938), executive (885), committee (736), employee (732), level (679), manager (639), report (538), split (492), year (433), policy (432), benefit (429), business (410), number (406)

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hr_narrative	right (14185), human (13765), policy (2195), principle (1964), business (1736), respect (1354), labour (1057), employee (1054), declaration (1033), community (923), universal (921), issue (859), standard (767), support (717), risk (684), social (677), security (646), environmental (609), commitment (584), guiding (556)

Panel A of this table presents descriptive statistics for the regression variables for the sample of treated and matched firms. Panel B shows the mean values and standard deviations (in parentheses) for the disclosure variables by year for the treatment and control group separately. Panel C of this table presents the top twenty words and their frequency (in parentheses) in the topic vocabularies (i.e., the retrieved ten-word windows) for measuring the narrative disclosure.

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Table 5: Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1)	1.0000																
(2)	0.5140	1.0000															
	(0.0000)																
(3)	0.6264	0.4401	1.0000														
	(0.0000)	(0.0000)															
(4)	0.6122	0.6413	0.6607	1.0000													
	(0.0000)	(0.0000)	(0.0000)														
(5)	0.5389	0.5048	0.6487	0.8328	1.0000												
	(0.0000)	(0.0000)	(0.0000)	(0.0000)													
(6)	0.0827	0.2675	0.0803	0.1648	0.0991	1.0000											
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)												
(7)	0.7126	0.5826	0.5789	0.7291	0.6257	0.0251	1.0000										
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.2179)											
(8)	0.1658	0.1875	0.1197	0.1523	0.1934	0.0886	-0.0010	1.0000									
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.9627)										
(9)	0.0968	0.0572	0.0808	0.0160	0.1146	0.0168	-0.0263	0.1944	1.0000								
	(0.0000)	(0.0049)	(0.0001)	(0.4321)	(0.0000)	(0.4095)	(0.1958)	(0.0000)									
(10)	-0.0284	0.0185	-0.0361	-0.0490	0.0334	0.0203	-0.1663	0.4669	0.3821	1.0000							
	(0.1630)	(0.3634)	(0.0760)	(0.0159)	(0.1009)	(0.3183)	(0.0000)	(0.0000)	(0.0000)								
(11)	0.0993	0.1423	0.0654	0.0714	-0.0161	0.0509	0.1511	-0.0389	0.0015	-0.0144	1.0000						
	(0.0000)	(0.0000)	(0.0013)	(0.0004)	(0.4283)	(0.0122)	(0.0000)	(0.0561)	(0.9398)	(0.4802)							
(12)	-0.0169	-0.0119	-0.0131	-0.1197	-0.1320	0.0399	-0.0672	-0.0237	0.0530	0.0121	0.0908	1.0000					
	(0.4054)	(0.5575)	(0.5212)	(0.0000)	(0.0000)	(0.0500)	(0.0009)	(0.2444)	(0.0092)	(0.5536)	(0.0000)						
(13)	0.0560	0.0877	0.0766	0.1076	0.1615	-0.0134	-0.0147	0.2238	0.2747	0.4760	-0.0608	-0.0060	1.0000				
	(0.0058)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.5111)	(0.4706)	(0.0000)	(0.0000)	(0.0000)	(0.0028)	(0.7671)					
(14)	-0.0435	-0.0200	-0.0460	0.0229	0.0553	-0.0003	-0.0227	-0.1709	-0.0172	-0.3912	-0.0891	-0.0956	0.0533	1.0000			
	(0.0324)	(0.3249)	(0.0238)	(0.2610)	(0.0066)	(0.9868)	(0.2645)	(0.0000)	(0.3991)	(0.0000)	(0.0000)	(0.0000)	(0.0087)				
(15)	-0.4090	-0.2885	-0.3805	-0.3932	-0.3264	-0.0123	-0.5911	0.1710	0.1404	0.4229	-0.1064	0.0399	0.2110	-0.0948	1.0000		
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.5455)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0496)	(0.0000)	(0.0000)			
(16)	0.3712	0.2854	0.3473	0.3197	0.3460	-0.0011	0.3441	0.1541	0.4184	0.2509	0.0228	0.0349	0.2363	-0.0468	-0.1817	1.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.9579)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.2623)	(0.0862)	(0.0000)	(0.0215)	(0.0000)		
(17)	0.0672	0.0585	0.0358	0.0594	0.0904	0.0002	-0.0308	0.2757	0.3322	0.5282	-0.1291	0.0235	0.4271	-0.0717	0.1920	0.2752	1.0000
	(0.0009)	(0.0040)	(0.0785)	(0.0035)	(0.0000)	(0.9919)	(0.1300)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.2478)	(0.0000)	(0.0004)	(0.0000)	(0.0000)	

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This table presents Pearson correlation coefficients and p-values (in parentheses) for a two-tailed test of statistical significance.
(1) ghg_KPI, (2) gender_KPI, (3) ghg_narrative (4) gender_narrative, (5) hr_narrative, (6) post, (7) treated, (8) report_length, (9) gri, (10) size, (11) roa, (12) lev, (13) analysts, (14) growth, (15) governance, (16) prior_discl, 17 (media)

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Table 6: Univariate difference-in-differences analysis

ghg_KPI

		post=0	*post=1*	
		(a)	*(b)*	*(b) – (a)*
treated=0	*(i)*	0.1239	0.1145	-0.0094
treated=1	*(ii)*	0.7599	0.8953	0.1354***
	(ii) – (i)	0.6360***	0.7808***	0.1448***

gender_KPI

		post=0	*post=1*	
		(a)	*(b)*	*(b) – (a)*
treated=0	*(i)*	0.0052	0.0101	0.0049
treated=1	*(ii)*	0.2967	0.7329	0.4362***
	(ii) – (i)	0.2915***	0.7228***	0.4313***

ghg_narrative

		post=0	*post=1*	
		(a)	*(b)*	*(b) – (a)*
treated=0	*(i)*	0.7545	0.8065	0.0521
treated=1	*(ii)*	2.4205	2.7764	0.3558***
	(ii) – (i)	1.6661***	1.9698***	0.3039***

gender_narrative

		post=0	*post=1*	
		(a)	*(b)*	*(b) – (a)*
treated=0	*(i)*	0.2085	0.2375	0.0290***
treated=1	*(ii)*	1.2413	1.7108	0.4695***
	(ii) – (i)	1.0328***	1.4733***	0.4405***

hr_narrative

		post=0	*post=1*	
		(a)	*(b)*	*(b) – (a)*
treated=0	*(i)*	0.6898	0.7668	0.0770**
treated=1	*(ii)*	1.6717	1.8713	0.1996***
	(ii) – (i)	0.9819***	1.1045***	0.1226**

This table presents the results from univariate difference-in-differences analysis. The table reports mean values of the dependent variables *ghg_KPI*, *gender_KPI*, *ghg_narrative*, *gender_narrative*, and *hr_narrative*. The sample is n=581 for treated=0 and post=0, n=594 for treated=0 and post=1, n=583 for treated=1 and post=0 and n=659 for treated=1 and post=1. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively, based on two-sided t-tests. We assess the statistical significance of the difference-in-differences values by comparing the mean values of firm-level pre/post changes in the dependent variables across treated and non-treated firms using t-tests.

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Table 7: Results of the regression analyses with moderating variables and firm-fixed effects

	ghg_KPI	*gender_KPI*	*ghg_narrative*	*gender_narrative*	*hr_narrative*
incentive=analysts:					
treated	0.5784***	0.2121***	1.4290***	0.8798***	0.9265***
	(12.9276)	(7.0451)	(9.1107)	(16.5051)	(13.5597)
postxtreated	0.1879***	0.4304***	0.4475***	0.4481***	0.1323***
	(4.3092)	(10.5333)	(4.4538)	(8.9571)	(2.6238)
incentive	-0.0460	-0.0077	-0.0436	0.0573	0.0940
	(-1.1723)	(-0.5169)	(-0.4331)	(1.6036)	(1.4099)
postxincentive	0.0635*	-0.0011	0.1789**	0.0156	0.0806*
	(1.8120)	(-0.1361)	(2.5475)	(0.9241)	(1.8250)
treatedxincentive	0.1378**	0.1671***	0.4931**	0.3022***	0.1498
	(2.3419)	(3.6421)	(2.1298)	(3.6721)	(1.4343)
postxtreatedxincentive	-0.1153**	-0.0116	-0.3056**	-0.0238	-0.0136
	(-2.0479)	(-0.2076)	(-2.0176)	(-0.2729)	(-0.1526)
R-squared	0.5538	0.5096	0.3687	0.6171	0.4780
incentive=growth:					
treated	0.6782***	0.3362***	1.8311***	1.0844***	0.9272***
	(17.1681)	(10.2907)	(10.0503)	(16.0683)	(11.2970)
postxtreated	0.1022***	0.4006***	0.2743***	0.3480***	0.1765***
	(2.7988)	(10.9185)	(2.9553)	(6.0972)	(3.1225)
incentive	-0.0020	0.0552***	0.0382	0.0895***	0.0569
	(-0.0506)	(3.7930)	(0.3591)	(2.9462)	(1.0228)
postxincentive	0.0271	0.0183*	0.0419	0.0327*	0.1184**
	(0.7632)	(1.8334)	(0.7006)	(1.8891)	(2.5466)
treatedxincentive	-0.0619	-0.0603	-0.2858	-0.0452	0.2228**
	(-1.0864)	(-1.3556)	(-1.3475)	(-0.5414)	(2.1659)
postxtreatedxincentive	0.0552	0.0324	-0.0041	0.1377*	-0.1322
	(0.9508)	(0.6008)	(-0.0248)	(1.7652)	(-1.5676)
R-squared	0.5522	0.4998	0.3645	0.6046	0.4777
incentive=governance:					
treated	0.6726***	0.2341***	1.7242***	1.0063***	1.0327***
	(15.6639)	(9.2946)	(10.1250)	(19.6529)	(14.5336)
postxtreated	0.1075***	0.4285***	0.3113***	0.4729***	0.1301***
	(2.7665)	(12.2376)	(3.6698)	(10.0156)	(2.6546)
incentive	0.0152	-0.0474***	-0.1044	-0.0094	0.0074
	(0.3550)	(-3.0956)	(-0.7289)	(-0.2487)	(0.1102)
postxincentive	-0.0399	-0.0061	-0.0298	0.0186	0.0124
	(-1.1913)	(-0.4052)	(-0.5417)	(0.9135)	(0.3183)
treatedxincentive	-0.0646	0.1964***	-0.3611	0.2017*	-0.0171
	(-0.9745)	(3.0779)	(-1.4756)	(1.7332)	(-0.1351)
postxtreatedxincentive	-0.0008	-0.0877	-0.1947	-0.2504***	-0.0928
	(-0.0123)	(-1.3192)	(-1.4514)	(-2.6315)	(-0.9375)
R-squared	0.5528	0.5026	0.3727	0.6014	0.4648
observations	2,417	2,417	2,417	2,417	2,417
controls	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES
firm cluster	YES	YES	YES	YES	YES

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Table 7: cont'd

	ghg_KPI	*gender_KPI*	*ghg_narrative*	*gender_narrative*	*hr_narrative*
incentive=prior_discl:					
treated	0.5988***	0.2112***	1.3346***	0.9601***	0.9012***
	(13.5872)	(6.2320)	(10.5500)	(14.7595)	(12.4150)
postxtreated	0.1809***	0.4294***	0.1751*	0.3518***	0.0507
	(3.5725)	(8.8147)	(1.6662)	(4.9961)	(0.7412)
incentive	0.0634*	-0.0163	0.1421	0.0214	0.0093
	(1.7490)	(-0.8152)	(1.4118)	(0.5961)	(0.1629)
postxincentive	0.1168***	-0.0073	0.1589**	0.0212	0.0793
	(2.9326)	(-0.4784)	(2.0536)	(0.6992)	(1.2849)
treatedxincentive	0.0368	0.1420***	0.4365**	0.1208*	0.1680**
	(0.6572)	(3.1966)	(2.4879)	(1.6934)	(2.1233)
postxtreatedxincentive	-0.1440**	-0.0166	0.0550	0.0766	0.0332
	(-2.2410)	(-0.2941)	(0.3679)	(0.7692)	(0.3240)
R-squared	0.5594	0.5041	0.3828	0.6049	0.4731
incentive=media:					
treated	0.6287***	0.2424***	1.5988***	0.9626***	1.0206***
	(15.4338)	(8.7438)	(9.8735)	(18.5837)	(14.9101)
postxtreated	0.1584***	0.4259***	0.3019***	0.4343***	0.0963*
	(3.9274)	(10.3934)	(2.6754)	(8.6427)	(1.6543)
incentive	0.0219	-0.0322**	-0.0437	0.0260	0.0127
	(0.6604)	(-2.0313)	(-0.4402)	(0.7321)	(0.2110)
postxincentive	0.0221	0.0032	-0.0208	0.0045	0.0135
	(0.6638)	(0.3354)	(-0.2498)	(0.2296)	(0.2524)
treatedxincentive	0.0364	0.1201***	0.1935	0.1720**	0.0020
	(0.6477)	(2.7034)	(0.8747)	(2.1376)	(0.0212)
postxtreatedxincentive	-0.0617	-0.0236	-0.0580	-0.0522	0.0140
	(-1.1254)	(-0.4193)	(-0.3254)	(-0.6477)	(0.1516)
R-squared	0.5521	0.5009	0.3627	0.6034	0.4645
observations	2,417	2,417	2,417	2,417	2,417
controls	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES
firm cluster	YES	YES	YES	YES	YES

This table reports coefficient estimates and t-statistics (in parentheses) based on OLS regressions with standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels (two-tailed), respectively.

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Table 8: Results of the regression analyses with separate interaction terms for each year

	ghg_KPI	*gender_KPI*	*ghg_narrative*	*gender_narrative*	*hr_narrative*
2011xtreated	-0.0652*	0.1604***	-0.0016	0.3056***	0.0440
	(-1.7720)	(4.3683)	(-0.0222)	(7.8832)	(0.9833)
2012xtreated	-0.0754*	0.2389***	-0.0057	0.4339***	0.0292
	(-1.8424)	(6.3648)	(-0.0713)	(9.8063)	(0.6326)
2013xtreated	0.0256	0.4684***	0.2888***	0.6361***	0.1122**
	(0.6128)	(11.2284)	(3.1851)	(12.0740)	(2.0440)
2014xtreated	0.1114***	0.5902***	0.4048***	0.7455***	0.2007***
	(3.0103)	(15.2744)	(4.2637)	(13.7468)	(3.4738)
2015xtreated	0.1076***	0.5926***	0.1308	0.6069***	0.0701
	(2.6166)	(14.9681)	(1.2764)	(11.3164)	(1.1427)
observations	2,417	2,417	2,417	2,417	2,417
R-squared	0.5523	0.5050	0.3626	0.6053	0.4649
controls	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES
firm cluster	YES	YES	YES	YES	YES

This table reports coefficient estimates and t-statistics (in parentheses) based on OLS regressions with standard errors clustered at the firm level for the parsimonious model without moderating effects and year-specific interactions instead of *postxtreated*. All analyses are presented for the sample of treated and matched firms (n=2,417). ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels (two-tailed), respectively.

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Table 9: Results of the regression analyses for alternative disclosure measures

Panel A: Correlation matrix for topic-specific disclosure measures based on word counts							
	(1)	***(2)***	***(3)***	***(4)***	***(5)***	***(6)***	***(7)***
(1) ghg_narrative	1.0000						
(2) gender_narrative	0.6607	1.0000					
	(0.0000)						
(3) hr_narrative	0.6487	0.8328	1.0000				
	(0.0000)	(0.0000)					
(4) count_ENV	0.4212	0.0871	0.1348	1.0000			
	(0.0000)	(0.0000)	(0.0000)				
(5) count_EMPL	0.1595	0.3093	0.3490	0.0816	1.0000		
	(0.0000)	(0.0000)	(0.0000)	(0.0001)			
(6) count_HR	0.1337	0.2802	0.3022	0.1071	0.8675	1.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
(7) count_SOC	0.0596	0.0974	0.1835	0.2075	0.5774	0.6348	1.0000
	(0.0034)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	

Panel B: Results for topic-specific disclosure measures based on word counts				
	count_ENV	***count_EMPL***	***count_HR***	***count_SOC***
postxtreated	0.0008	0.0026*	0.0024***	0.0007
	(0.8636)	(1.6822)	(3.1953)	(0.8073)
observations	2,417	2,417	2,417	2,417
controls	YES	YES	YES	YES
year FE	YES	YES	YES	YES
firm cluster	YES	YES	YES	YES

Panel C. Results for other textual attributes				
	tone	***readability***	***ratio_numbers***	***length***
postxtreated	0.0002	0.0827***	0.1398***	0.2028***
	(0.6379)	(6.1783)	(3.9601)	(4.9292)
observations	2,417	2,417	2,417	2,417
controls	YES	YES	YES	YES
year FE	YES	YES	YES	YES
firm cluster	YES	YES	YES	YES

Panel A of this table presents Pearson correlation coefficients and p-values (in parentheses) for a two-tailed test of statistical significance. Panel B of this table reports coefficient estimates and t-statistics (in parentheses) from OLS regressions for the disclosure measures that are constructed based on the frequency of words from the sustainability dictionary developed by Pencle and Mălăescu (2016). Standard errors are clustered at the firm level. Panel C of this table reports coefficient estimates and t-statistics (in parentheses) from OLS regressions for textual attributes. All analyses are presented for the sample of treated and matched firms (n=2,417) and refer to the parsimonious model without moderating effects. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels (two-tailed), respectively.

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Appendix I

Details on the construction of the disclosure measures

General procedure analogous to Hoberg and Maksimovic (2015) and Hummel et al. (2017)

The construction of *KPI* disclosure measures:

1. For each topic, we query according to predefined logical expressions across all documents. In particular, with respect to disclosure of
   a) GHG emissions, the following logical expression is used for the search query: ("tonne" OR "ton" OR "numeric") AND ("GHG" or "*CO2*" OR "carbon" OR ("greenhouse" AND "gas"))
   b) gender distribution, the following logical expression is used for the search query: (("female" OR "gender" OR "woman" or "sex") AND ("board" OR "director" OR "executive" OR "manager" or "employee") AND "numeric") OR (("gender" AND "distribution") OR ("gender" AND "split") OR ("gender" AND "breakdown") AND "numeric")

2. *ghg_KPI* and *gender_KPI* take on the value of "1" if the report loads on the search query and "0" otherwise.

The construction of topic-specific narrative disclosure measures:

1. Let N denote the number of unique words in the entire corpus.

2. For each topic, we query according to predefined logical expressions across all documents. In particular, with respect to disclosure on
   a) GHG emissions, the following logical expression is used for the search query: ("ghg" AND "emission") OR ("*CO2*" AND "emission") OR ("carbon" AND "dioxide") OR ("greenhouse" AND "gas") OR ("climate" AND "change") OR ("kyoto" AND "protocol") OR ("global" AND "warming")
   b) gender distribution, the following logical expression is used for the search query: ("gender" AND "split") OR ("gender" AND "diversity") OR ("gender" AND "distribution") OR ("gender" AND "breakdown") OR ("female" AND "manager") OR ("woman" AND "manager") OR ("female" AND "management") OR ("woman" AND "management") OR ("female" AND "director") OR ("woman" AND "director") OR ("female" AND "executive") OR ("woman" AND "executive") OR ("female" AND "board") OR ("woman" AND "board")
   c) human rights, the following logical expression is used for the search query: "human" AND "right"

3. For each topic, we aggregate all retrieved ten-word windows into a topic-specific vocabulary list. The vocabulary list includes all words that appear in all retrieved ten-word windows for each topic.

4. For each topic, we define an N-vector *search* that is filled with the term -frequency-inverse-document-frequency (tf-idf) of each word in the topic vocabulary corresponding to each of the N elements.

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5. For each firm *i* in each year *t*, we define an N-vector $text_{i,t}$ that is filled with the tf-idf for each word in firm i's annual report in year t corresponding to each of the N elements.[38]

6. For each element of the N-vector, the inverse-document-frequency (idf) is calculated according to

   (1) $idf = log_2 \frac{n}{f}$

   where n: number of all documents
   f: number of documents in which the word appears

7. For each element of the N-vector search, the tf-idf is calculated as the product of the number of times the word appears in the training set and the idf.

8. For each element of the N-vector $text_{i,t}$, the tf-idf is calculated as the product of the number of times the word appears in the annual report of firm i in year t (i.e., the term frequency) and the idf.

9. To neutralize the impact of the document length, we normalize the N-vector search according to

   (2) $search\_norm = \frac{search}{\sqrt{search \cdot search}}$

10. Similarly, we normalize the N-vector $text_{i,t}$ according to

    (3) $norm_{i,t} = \frac{text_{i,t}}{\sqrt{text_{i,t} \cdot text_{i,t}}}$

11. To obtain the similarity between firm i's annual disclosure in year t and the topic vocabulary, we calculate $similarity_{i,t}$ as the cosine similarity (i.e., the dot product) between $norm_{i,t}$ and *search_norm*.

    (4) $similarity_{i,t} = norm_{i,t} \cdot search\_norm$

12. For conventional reasons, the cosine similarity is multiplied by 100.

[38] Note that Hoberg and Maksimovic (2015) simply use a vector of word counts (i.e., the term frequency) instead of the tf-idf. In contrast, the tf-idf incorporates a term weighting procedure (i.e., the inverse document frequency) and adjusts a word's weight based on how (un)usual the word is. It thus reflects the importance of a word in a specific document relative to the importance of that word in the entire corpus. The more unusual the word, the higher the weight (Loughran and McDonald 2016).

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A simple example for the calculation of the cosine similarity (analogous to Hummel et al. (2017))

1. Consider three texts that, after application of the preprocessing methods, can be described according to the following word lists:

   text_1 = [“employee”, “educate”, “women”]
   text_2 = [“engage, “board”, “gender”, “composition”, “women”]
   text_3 = [“board”, “composition”, “engage”, “educate”, “women”]

2. Consider the following training set (as a result of the search query):

   search = [“gender”, “board”, “women”]

3. The corpus is given by

   corpus = [“gender”, “board”, “women”, “composition”, “engage”, “employee”, “educate”]

4. The inverse-document-frequency for each word corresponds to

   w_{gender} = 1.5850
   w_{board} = 0.5850
   w_{women} = 0.0000
   $w_{composition}$ = 0.5850
   w_{engage} = 0.5850
   $w_{employee}$ = 1.5850
   $w_{educate}$ = 0.5850

5. The tfidf-vector for the training set and each text corresponds to

   search = [1.5850, 0.5850, 0.0, 0.0, 0.0, 0.0, 0.0]
   text_1 = [0.0, 0.0, 0.0, 0.0, 0.0, 1.5850, 0.5850]
   text_2 = [1.5850, 0.5850, 0.0, 0.5850, 0.5850, 0.0, 0.0]
   text_3 = [0.0, 0.5850, 0.0, 0.5850, 0.5850, 0.0, 0.5850]

6. The normalized tfidf-vector for the training set and each text corresponds to

   norm_search = [0.9381, 0.3462, 0.0, 0.0, 0.0, 0.0, 0.0]
   norm_text_1 = [0.0, 0.0, 0.0, 0.0, 0.0, 0.9381, 0.3462]
   norm_text_2 = [0.8426, 0.311, 0.0, 0.311, 0.311, 0.0, 0.0]
   norm_text_3 = [0.0, 0.5, 0.0, 0.5, 0.5, 0.0, 0.5]

7. The cosine similarity for each text corresponds to

   similarity_text_1 = norm_search · norm_text_1 = 0.0000
   similarity_text_2 = norm_search · norm_text_2 = 0.8981
   similarity_text_3 = norm_search · norm_text_3 = 0.1731

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Appendix II

Examples of incorrect classifications with regard to *ghg_KPI* and *gender_KPI*

We manually checked the validity of the disclosure measures, particularly with regard to the disclosure of key performance indicators. The results indicate that the textual analysis might not correctly identify the disclosure of the key performance indicators in some cases. The following table provides examples of incorrect classifications.

Firm and year	Results from textual analysis	Corresponding word window
CIK=27904, year=2015	ghg_KPI=1	In addition, at the 38th ICAO Assembly that concluded on October 4, 2013 in Montreal, the Assembly adopted a climate change resolution committing ICAO to develop a global market-based measure to be finalized at the 2016 ICAO Assembly that would enable the airline industry to achieve carbon-neutral growth by 2020.
CIK=4447, year=2015	ghg_KPI=1	Excludes approximately 255 million mcf of carbon dioxide gas for sale or use in company operations.
ISIN=GB0009223206, year=2014	ghg_KPI=0	Reported in table on page 41.
ISIN=GB00B1L5QH97, year=2015	ghg_KPI=0	Reported in table on page 37.
CIK=1037976, year=2015	gender_KPI=1	During 2015, we were recognized for excellence in global corporate governance by the India Institute of Directors and for gender diversity on our Board of Directors by the 2020 Women on Boards.
CIK=1005817, year=2011	gender_KPI=1	1.5 Surviving Spouse means the spouse of the Executive surviving on the date of death of the Executive. 1.6 The masculine gender, where it appears in this Agreement, will be deemed to include the feminine gender, and the singular may include the plural, unless the context clearly indicates the contrary.
ISIN=GB00BJ62K685, year=2014	gender_KPI=0	Reported in table on page 55.
ISIN=GB0004228648, year=2015	gender_KPI=0	The Company has no employees. Its board is made up of five directors, all male.

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